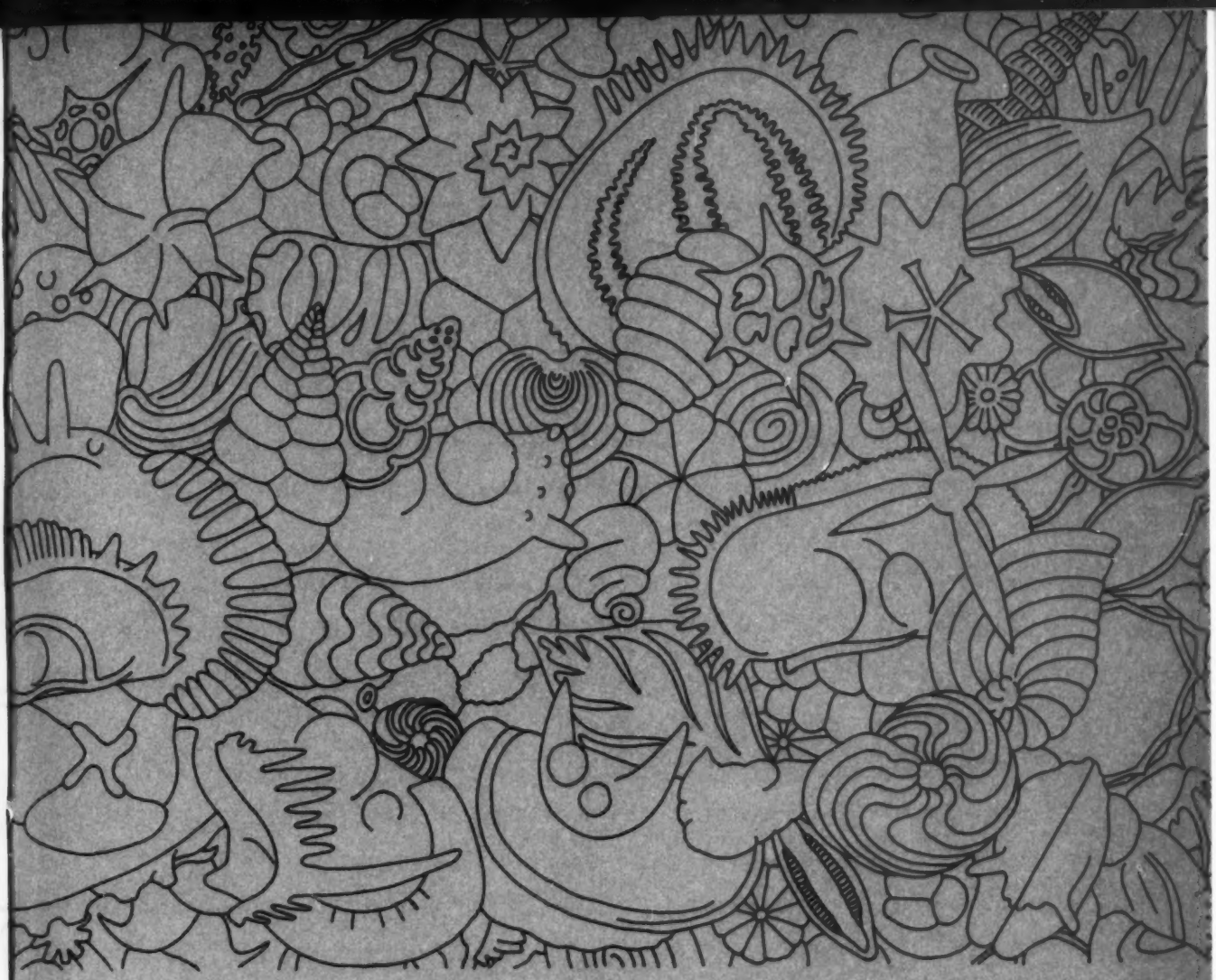

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ABSTRACT: *An abundant and highly varied spore florule present in coal of lowermost Mississippian age is described and illustrated. The assemblage consists of nineteen genera and fifty species, of which four genera, thirty species and fourteen types (of which only one or two specimens were found) are proposed as new. Simple, almost smooth, trilete spores of the genus* Punctatisporites *Potonié and Kremp, 1954, largely predominate, reaching 68 per cent in one sample. The presence of several types that possess a thick perispore is significant. The aspect of the spore florule is more Devonian than Carboniferous, and this florule resembles florules reported from Upper Devonian strata, particularly of the U.S.S.R. A continuation of the Upper Devonian flora into the lower portion of the Lower Carboniferous, as observed in the megaflora, is therefore also indicated by the microflora.*

Plant spores in coal from the Horton group (Mississippian) of Nova Scotia*

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INTRODUCTION

The stratigraphic significance of fossil spores is now generally recognized, and the value of spore studies in coal mining as well as in the oil industry has been shown by the ever-increasing number of publications on this subject. In Nova Scotia, a very large field for spore investigation is available in the Carboniferous succession, which in this province ranges from the lowermost Mississippian into the Upper Pennsylvanian. Only a small portion of this column has been studied to date.

The first reports on the Pennsylvanian spores of Nova Scotia are those of Grace Somers. In 1952, she published two papers on the small-spore content of two coal seams in the Sydney coal field. In the same year, L. R. Wilson reported on small spores from Division Four of the Pennsylvanian of the Joggins section.

The present report, which is the first publication on the Mississippian spores of Nova Scotia, discusses the small spores present in two coals of the Horton group in the Windsor area. The paper is a progress report on a systematic spore study of the Horton group in Nova Scotia, and was presented at the Third Conference on the Origin and Constitution of Coal, held in Nova Scotia in June 1956. In view of the many new forms encountered and the paucity of literature on lowermost Mississippian spores, it was deemed advisable to publish the report in a paleontological journal rather than in the conference proceedings.

The author wishes to thank M. S. Barss, of the staff of the Sydney office of the Geological Survey of Canada, for his work on the photomicrographs and for his constructive comments on the new genera and species that are described in this report. Further thanks are extended to Dr. B. C. Murray, who, in 1954, as a graduate student at Massachusetts Institute of Technology, made the coal samples available and proposed the spore investigation.

STRATIGRAPHY AND AGE OF THE HORTON GROUP

Strata belonging to the Horton group are widespread in Nova Scotia and New Brunswick. They constitute the first sedimentary deposits laid down after the Acadian Revolution, and lie between mid-Devonian granites and Upper Mississippian marine sediments of the Windsor series. The Horton succession consists of conglomerates, sandstones, and shales of continental origin, and in Nova Scotia

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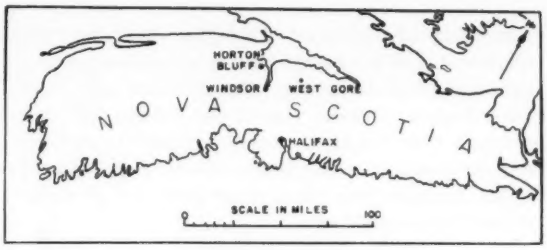
attains a maximum thickness of some 8000 feet. Coal is known at only a few localities, and nowhere reaches a minable thickness, but because it is of a high-volatile bituminous rank, it provides excellent material for spore investigations. With the exception of the Windsor area, where Bell (1929) recognized a lower Horton Bluff and an upper Cheverie formation, the Horton strata have been mapped as a single unit throughout Nova Scotia. This is due mainly to the paucity of fossil remains and the general lithologic similarity of the rocks in different parts of the section. In 1955, however, Murray proposed a threefold division, which he recognized in different parts of the province and which is based on lithology only. Paleontological evidence is therefore necessary in order to verify the correlation proposed by Murray and to test the validity, as time units, of his three lithologic members of the Horton group. For this purpose, a spore investigation offers good possibilities, particularly because few megafossils have been found, and because those that have been found cannot readily be used as index fossils within the Horton group.

Murray, who realized the possible value of fossil spores in the stratigraphy of the Horton group, collected samples of carbonaceous material and made them available to the author. The study was commenced with two samples from the Windsor area because this is the only area from which megafossils were obtained that permitted a more precise fixing of the position of the Horton strata within the long time-interval from mid-Devonian to Upper Mississippian (Bell, 1929). The oldest Horton strata of this area, those of the Horton Bluff formation, are regarded by Bell as early Mississippian, comparable in age to the Pocono strata of the Appalachian region, mainly because of the presence of *Aneimites acadica* Dawson and *Lepidodendron corrugatum*. A younger age is indicated for the overlying Cheverie formation, but the megafossils are of insufficient diagnostic value to define its position within the Mississippian. Bell (1929) tentatively considered the Cheverie as lying closer to Windsor (late Mississippian) than to Horton Bluff time.

DATA ON SAMPLE LOCALITIES

The two samples discussed in this report were collected by Murray at station no. 1, Blue Beach, near Horton Bluff, situated on the west shore of the Avon River, 8 miles northwest of Windsor, and at station no. 2, McLean Brook, near West Gore, 20 miles northeast of Windsor. (See text-figure 1.) The Blue Beach sample was taken from a thin layer of coaly shale $\frac{1}{8}$ inch thick, which is part of the type section



TEXT-FIGURE 1

INDEX MAP OF SAMPLE LOCALITIES

of the Horton Bluff formation. The West Gore sample was obtained from an outcrop of fine-grained sandstone and shale with interbedded layers of coal.

For maceration, several small blocks of coal were collected from the West Gore outcrop, which is indicated as a prospect pit on Fletcher's Kennetcook Sheet no. 65, published in 1905 by the Geological Survey of Canada. At this locality, the Horton strata are considered by Murray (1955) to be equivalent to the Cheverie formation. However, this opinion is contrary to that of Bell, who regards these beds as belonging to the basal part of the Horton Bluff formation (1956, written communication). Correlation with the Horton Bluff formation appears to be more logical to the author because, in the general area of Gore, there are several coal occurrences indicated on Fletcher's map. Similar occurrences are present at other localities in Nova Scotia in Horton beds that Murray regards as the equivalent of the Horton Bluff formation, whereas coal has not been reported from the Cheverie formation. Although no spore analysis has yet been made of the type section of the Cheverie formation, the present study supports a Horton Bluff age for the West Gore sample.

SPORE ASSEMBLAGE OF THE BLUE BEACH SAMPLE

A good maceration was not obtained from the Blue Beach (Horton Bluff) sample. The sample contained only a very small amount of coal, which, moreover, was highly contaminated with shale. Only a few hundred spores were isolated, and the majority of them were poorly preserved specimens. Nevertheless, it was possible to recognize eighteen genera and thirty-seven species.

In general, this assemblage is similar to the one present in the West Gore sample. All but three genera (*Calamospora*, *Triquitrites* and *Cirratriradites*) are also present at West Gore. The remaining fifteen genera are: *Punctatisporites*, *Cyclogranisporites*, *Lopho-*

triletes, *Acanthotriletes*, *Raistrickia*, *Verrucosisporites*, *Microreticulatisporites*, *Lycospora*, *Vallatisporites*, n. gen., *Stenozonotriletes* Naumova, 1937, emend., *Leiozonotriletes*, n. gen., *Spinozonotriletes*, n. gen., *Endosporites*, *Grandispora* Hoffmeister, Staplin and Malloy, 1955, and *Pityosporites*. These genera are those recognized by Potonié and Kremp (1954), except those for which the author has been explicitly indicated.

Of the thirty-seven species, twenty-three also occur in the West Gore sample. They are indicated in Table 1, and include the following six species that are abundantly represented in the West Gore assemblage: *Punctatisporites irrasus*, n. sp.; *Punctatisporites debilis*, n. sp.; *Punctatisporites planus*, n. sp.; *Punctatisporites viriosus*, n. sp.; *Cyclogranisporites* sp. cf. *C. pressoides*; and *Lycospora torulosa*, n. sp. Only *Grandispora echinata*, n. sp., which reaches 9 per cent at West Gore, was not observed here. Besides these more abundant types from West Gore, several remarkable species of that assemblage are also present in the Blue Beach sample, for example, *Cyclogranisporites naevulus*, n. sp.; *Acanthotriletes horridus*, n. sp.; *Vallatisporites vallatus*, n. sp.; *Stenozonotriletes?* sp. cf. *Z. stenozonalis* Waltz, 1938; *Leiozonotriletes* sp. cf. *Archaeozonotriletes primarius* Naumova, 1953; *Spinozonotriletes tenuispinus*, n. sp.; *Endosporites micromanifestus*, n. sp.; *Grandispora?* sp. *A*; and *Pityosporites* sp. *A*.

The fourteen species present that do not occur in the West Gore sample are probably all new species, but the nature of the maceration prohibited a detailed study. It is therefore necessary for additional samples to be obtained from the Horton Bluff area to supplement the present study.

SPORE ASSEMBLAGE OF THE WEST GORE SAMPLE

From the preceding section, it appears that the West Gore and Blue Beach samples very probably belong to the same formation, that is, the Horton Bluff formation. However, this cannot be definitely stated until the spores of the Cheverie formation have been studied. In this connection it can be pointed out that Bell (1929) reported several additions to the flora of the Cheverie formation as compared with that of the Horton Bluff formation. Together with a change in sedimentation, this difference may indicate an important change in climatic conditions between the two formations. Such a change would certainly be expressed in the spore florule, and a great difference between the spore assemblages of the two samples would be expected if they belonged to these two different formations. As was mentioned previously, no great difference was observed.

Composition of the assemblage

A very good maceration was obtained from the West Gore sample, which yielded abundant and well-preserved specimens, as may be seen from the sixty-eight photomicrographs presented in plates 1–3. In this maceration, a highly varied and abundant spore florule is represented by nineteen genera and fifty species. Four of the genera are new, and there are thirty new species and fourteen new types, of which only one or two specimens were found. Only six species could be positively or nearly positively identified with forms that have been described previously.

The genera proposed as new are: *Vallatisporites* (4), *Leiozonotriletes* (4), *Spinozonotriletes* (2), and *Lepidozonotriletes* (1). Previously described genera recorded are: *Leiotriletes* (2), *Punctatisporites* (6), *Cyclogranisporites* (3), *Lophotriletes* (1), *Acanthotriletes* (2), *Raistrickia* (6), *Verrucosisporites* (1), *Microreticulatisporites* (1), *Reticulatisporites* (1), *Convolutispora* Hoffmeister, Staplin and Malloy, 1955 (2), *Lycospora* (1), *Stenozonotriletes* Naumova, 1937, emend. (5), *Endosporites* (3), *Grandispora* Hoffmeister, Staplin and Malloy, 1955 (2), and *Pityosporites* (1). In this enumeration, the figure in parentheses denotes the number of species assigned to each genus. The genera listed are those recognized by Potonié and Kremp (1954), except those for which the author is explicitly indicated. The names of the various species, as well as references to illustrations and observed size-ranges, will be found in Table 1.

The quantitative amounts in which the different genera and species are present in the West Gore assemblage were obtained from a statistical count of two hundred spores. The detailed results of this count are as follows:

GENERA

	Per cent
Punctatisporites	68
Grandispora	9
Lycospora	4
Vallatisporites	4
Endosporites	4
Verrucosisporites	3
Spinozonotriletes	2
Cyclogranisporites	1
Raistrickia	1
Stenozonotriletes	1
Lepidozonotriletes	1
Other genera	2

SPECIES
(per cent of total assemblage)

	Per cent
Punctatisporites irrasus	31
Cyclogranisporites sp. cf. *C. pressoides*	15
Grandispora echinata	9
Punctatisporites debilis	8
Punctatisporites planus	6
Punctatisporites viriosus	5
Lycospora torulosa	4
Endosporites micromanifestus	4
Punctatisporites? limbatus	3
Verrucosisporites papulosus	3
Vallatisporites vallatus	2
Vallatisporites verrucosus	2
Spinozonotriletes uncatus	2
Cyclogranisporites naevulus	1
Stenozonotriletes extensus var. *major*	1
Lepidozonotriletes aculeatus	1
All other species (less than 1 per cent each)	3

The count reveals that *Punctatisporites* is the dominant genus and greatly exceeds the total of all other genera combined. Of this genus, *Punctatisporites irrasus*, n. sp., constitutes about one-third of all spores present. The genus *Punctatisporites*, as defined by Potonié and Kremp (1954), comprises simple forms that are devoid of ornamentation (sculpture) but possess an internal structure of the exine that may be punctate, infrareticulate, or infragranulose. The genus resembles *Calamospora*, but differs in having longer rays (more than half the spore radius) and in not possessing contact areas. *Calamospora*, moreover, usually has a thin, smooth exine without a distinct internal structure.

Potonié and Kremp transferred several species that were included in *Calamospora* by Schopf, Wilson and Bentall (1944) to *Punctatisporites* Potonié and Kremp, 1954. The species of the West Gore and Blue Beach samples assigned to *Punctatisporites* Potonié and Kremp would probably all be classed as *Calamospora* if the classification of Schopf, Wilson and Bentall (1944) had been followed. According to this classification, *Calamospora*, rather than *Punctatisporites*, would then be the dominant genus.

Grandispora is the next most abundant genus, although it constitutes only 9 per cent of the whole assemblage. This genus was first described by Hoffmeister, Staplin and Malloy (1955*b*) from the Upper Mississippian Hardinsburg formation of Illinois and Kentucky, but in that formation it is rare. The genus comprises monosaccate spores with a spinose bladder, which distinguishes them from other known bladder spores, such as *Endosporites*, that possess a bladder devoid of sculpture and contain only an internal structure. The entire 9 per cent consists of a single species, *Grandispora echinata*, n. sp.

Next to *Grandispora*, there are five genera that are regularly encountered in the slides but that range numerically only from 2 to 4 per cent. They may be more abundant in certain layers of the section, but since only a few blocks of coal were available, this could not be determined. These genera include two that are considered to be new, *Vallatisporites* and *Spinozonotriletes*. The first of these resembles *Densosporites* but, unlike this genus, possesses a well-defined central body that is separated from the equatorial portion by a distinct groove, and has rays that may extend to the equator. *Vallatisporites* is believed to have a perispore that extends beyond the margin of the body in the form of a flange, which tapers toward the periphery. The 4 per cent represented by this genus is equally divided between two species, *Vallatisporites vallatus*, n. sp., and *Vallatisporites verrucosus* n. sp. *Spinozonotriletes*, n. gen., is characterized by a central body and a thick perispore that extends beyond the body margin in the form of a flange. The perispore carries well developed spines that radiate from both body margin and equator. *Spinozonotriletes uncatus* accounts for the 2 per cent by which this genus is represented. All other genera are rare, and represent 1 per cent or less of the total assemblage.

Comparison with Lower Carboniferous and Devonian spores of other regions

The abundant spore florule is in sharp contrast with the number of plant species that have been found in the Horton Bluff formation in particular and the Horton group in general. Bell (1929) mentions only six different plant species from the Horton Bluff formation, of which *Aneimites acadica* Dawson and *Lepidodendron corrugatum* are indicative of an early Mississippian age, not later than Kinderhookian. This age assignment is supported by fish remains such as *Elonichthys* and *Rhadinichthys*, as well as by ostracodes such as *Kirkbyina* sp. and *Jonesina novascotica*, which likewise point to a Carboniferous age.

According to Bell, a Lower Carboniferous age is thus well established for the Horton Bluff formation, but the spore florules encountered in the Blue Beach and West Gore samples are unlike any reported from Lower Carboniferous strata. Only five species resemble those described from the Lower Carboniferous: *Punctatisporites viriosus*, n. sp., which is comparable with *Punctatisporites? callosus* Hoffmeister, Staplin and Malloy, 1955, present in Illinois and

TABLE 1

INDEX TO SPECIES PRESENT IN WEST GORE AND BLUE BEACH SAMPLES WITH REFERENCES TO COMPARABLE SPECIES REPORTED FROM DEVONIAN AND CARBONIFEROUS STRATA OF OTHER REGIONS

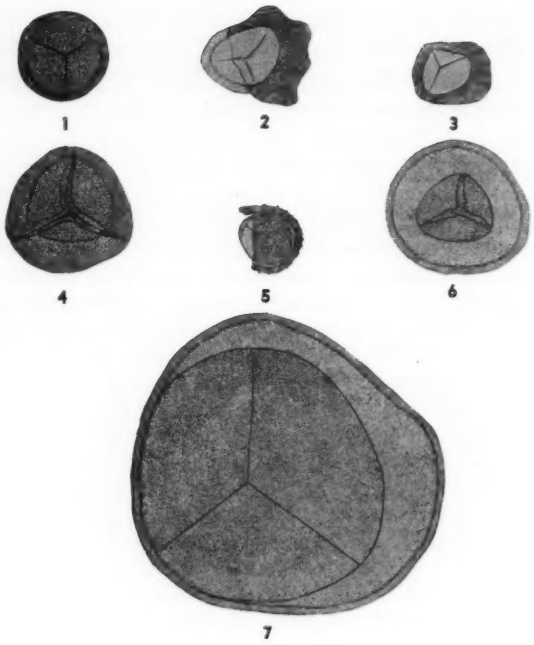
West Gore	Blue Beach	Pl.	Fig.	Diameter in microns	Comparable species[1])	Occurrence	Age
Leiotriletes notatus sp. nov.		1	1–2	41—54			
Leiotriletes sp. *A*		1	3–4	47×47	*Granulati-sp. adnatus* Kos.[2]) 1950	Illinois	Pennsylvanian
Punctatisporites debilis sp. nov.	X	1	5–6	41—58	Sp. V B, Thomson, 1940	Estonia	Middle Devonian
Punctatisporites irrasus sp. nov.	X	1	7–8	67—83	Type D, Lang, 1925	Scotland	Devonian
Punctatisporites? limbatus sp. nov.		1	9–11	111—206	1. Type C, Lang, 1925	Scotland	Devonian
					2. Sp. III C, Thomson, 1940	Estonia	Middle Devonian
					3. *Calamospora?* H.S. & M. 1955*a*, pl. 1, fig. 11	Alberta	Upper Devonian
Punctatisporites planus sp. nov.	X	1	12	50—64			
Punctatisporites solidus sp. nov.		1	13	50—64	Sp. V A, Thomson, 1940	Estonia	Middle Devonian
Punctatisporites viriosus sp. nov.	X	1	14	68—83	*P.? callosus* H.S. & M., 1955*b*	Illinois Kentucky	Upper Mississippian
Cyclogranisporites naevulus sp. nov.	X	1	15	60—90	*Leiotriletes atavus* Naum. 1953	U.S.S.R.	Upper Devonian
Cyclogranisporites sp. cf. *C. pressoides*	X	1	16	27—34	*C. pressoides* Pot. & Kr. 1955	Ruhr	Upper Carbon.
Cyclogranisporites sp. *A*		1	17	146×152			
Lophotriletes sp. *A*	X	1	18	33×35	*Acanthotr. parvus* Naum. 1953	U.S.S.R.	Upper Devonian
Acanthotriletes horridus sp. nov.	X	1	20	124—170	*Apiculati* sp., Hoeg, 1942, pl. 31, figs. 14–15	Spitzbergen	Middle? Devonian
Acanthotriletes sp. *A*		1	19	33×39			
Raistrickia ampullacea sp. nov.		1	21–22	47—54			
Raistrickia baculosa sp. nov.	X	1	23–24	72—107	*R. saetosa* (Loose) S.W. & B. 1944	Ruhr	Upper Carbon.
Raistrickia clavata sp. nov.		1	25	58×62			
Raistrickia? gibberosa sp. nov.		2	1	76×76	Type J 5, Radforth & McGregor, 1954	Gaspé	Middle Devonian
Raistrickia pistillata sp. nov.		2	2	72—84			
Raistrickia sp. *A*		2	3	45—54			
Verrucosisporites papulosus sp. nov.	X	2	4–5	50—62	Type H 6, Radforth & McGregor, 1954	Gaspé	Middle Devonian
Microreticulatisporites sp. *A*		2	6	50×58			
Reticulatisporites sp. cf. *R. reticulatus*		2	7	90—93	*R. reticulatus* Ibr. 1932	Ruhr	Upper Carbon.
Convolutispora flexuosa forma *major* sp. nov.		2	8–9	124—255	*Convolutispora* H.S. & M., 1955*a*, pl. 1, fig. 2	Alberta	Upper Devonian
Convolutispora flexuosa forma *minor* sp. nov.		2	10	55×72			
Lycospora torulosa sp. nov.	X	2	11	41—53	*Stenozonotr. fumanus* Naum. 1953	U.S.S.R.	Upper Devonian
Vallatisporites vallatus sp. nov.	X	2	12	60—70	*Hymonozonotr. meonacanthus* Naum. 1953	U.S.S.R.	Upper Devonian
Vallatisporites verrucosus sp. nov.	X	2	13	55—64			
Vallatisporites sp. *A*		2	14	68×68	*Hymonozonotr. deliquescens* Naum. 1953	U.S.S.R.	Upper Devonian
Vallatisporites sp. *B*		2	15	80×84	*Hymonozonotr. speciosus* Naum. 1953	U.S.S.R.	Upper Devonian
Stenozonotriletes sp. cf. *S. conspersus*		2	16	35×37	*S. conspersus* Naum. 1953	U.S.S.R.	Upper Devonian
Stenozonotriletes deltoides sp. nov.	X	2	17–18	74—119	Sp. III B, Thomson, 1940	Estonia	Middle Devonian
Stenozonotriletes extensus var. *major*	X	2	19–20	55—78	*S. extensus major* Naum. 1952	U.S.S.R.	Upper Devonian
Stenozonotriletes? sp. cf. *Z. stenozonalis*	X	2	21	74—89	*Zonotr. stenozonalis* Waltz, 1938	U.S.S.R.	Lower Carbon.
Stenozonotriletes sp. *A*	X	2	22	47—53	*S. informus* Naum. 1953	U.S.S.R.	Upper Devonian
Leiozonotriletes insignitus sp. nov.		3	1	70—103			
Leiozonotriletes meracus sp. nov.		3	2–3	50—67	1. *Archaeozonotr. purus* Naum. 1953		
					2. *A. compactus* var. *famenensis* Naum. 1953	U.S.S.R.	Upper Devonian
Leiozonotriletes sp. cf. *Archaeozonotriletes primarius*	X	3	4	86×86	*Archaeozonotr. primarius* Naum. 1953	U.S.S.R.	Upper Devonian
Leiozonotriletes sp. *A*		3	5	97×117			
Spinozonotriletes tenuispinus sp. nov.	X	3	6–7	103—113	Type D, H.S. & M., 1955*b*	Illinois Kentucky	Upper Mississippian
Spinozonotriletes uncatus sp. nov.	X	3	8–10	82—148	1. Type G, Lang, 1925	Scotland	Devonian
					2. *Archaeozonotr. aduncus* Naum. 1953 (N.B. *S. uncatus* has no grapnel-like spines)	U.S.S.R.	Upper Devonian
Lepidozonotriletes aculeatus sp. nov.		3	11–12	103—195			
Endosporites angustus sp. nov.		3	13	110—165	*Hymonozonotr. platyrugosus* Naum. 1953	U.S.S.R.	Upper Devonian
Endosporites macromanifestus sp. nov.		3	14–15	122—173	Type A, Lang, 1925	Scotland	Devonian
Endosporites micromanifestus sp. nov.	X	3	16	58—100	1. *Hymonozonotr. variabilis* Naum. 1953	U.S.S.R.	Upper Devonian
					2. *Zonotr. elegans* Waltz, 1938	U.S.S.R.	Lower Carbon.
Grandispora echinata sp. nov.		3	17	62—93	*Hymonozonotr. medius* Naum. 1953	U.S.S.R.	Upper Devonian
Grandispora? sp. *A*	X	3	18	87×113			
Pityosporites sp. *A*	X	3	19	39×72	This genus also reported by Radforth & McGregor, 1954	Alberta	Upper Devonian
Spore type A		3	20	103×130	Sp. I C, Thomson, 1940	Estonia	Middle Devonian
Spore type B		3	21	130—175	*Cirratriradites latitriletes* H. & B., 1957	Western Canada	Mississippian

[1]) The resemblance is in most instances a general one, because in the older publications the spores are described inadequately for detailed comparisons.
[2]) The following author abbreviations have been used: Kos. for Kosanke; H.S. & M. for Hoffmeister, Staplin & Malloy; Naum. for Naumova; Pot. & Kr. for Potonié & Kremp; S.W. & B. for Schopf, Wilson & Bentall; Ibr. for Ibrahim; H. & B. for Hacquebard & Barss.

Kentucky; *Stenozonotriletes?* sp. cf. *Z. stenozonalis* Waltz, 1938, present in the U.S.S.R.; *Spinozonotriletes tenuispinus*, n. sp., which resembles Spore type D of Hoffmeister, Staplin and Malloy (1955), from Illinois and Kentucky; *Endosporites micromanifestus*, n. sp., which may be similar to *Zonotriletes elegans* Waltz, 1938, present in the U.S.S.R.; and Spore type B, which resembles *Cirratriradites latitriletes* Hacquebard and Barss, 1957, present in western Canada. To this list may be added three genera that are considered to be characteristic of the Lower Carboniferous: *Stenozonotriletes* Naumova, 1937, reported from the U.S.S.R. only; and *Grandispora* Hoffmeister, Staplin and Malloy, 1955, and *Convolutispora* Hoffmeister, Staplin and Malloy, 1955, which are known from the Upper Mississippian of Illinois and Kentucky. Of these three genera, *Stenozonotriletes* and possibly *Grandispora* occur also in the Upper Devonian of the U.S.S.R. (Naumova, 1953). However, the slight resemblance between the Horton spore florules and those reported from Lower Carboniferous beds elsewhere does not have much significance to date, because very few spore studies have been made of the lowermost portion of the Lower Carboniferous.

A much greater resemblance is noted when the Horton spores are compared with those described from Devonian strata, particularly with those found by Naumova (1953) in the Upper Devonian of the U.S.S.R. Twenty-seven of the fifty species present in the West Gore assemblage show a general resemblance to spores reported from Middle and Upper Devonian strata in various parts of the world, such as Alberta, Gaspé, Spitzbergen, Scotland, Estonia and Russia (see Table 1). The spores described from the Devonian of these areas, except those of Russia, are mainly to be found in older publications, and systematic descriptions in accordance with modern taxonomic views are therefore not given. The resemblance noted is therefore only a general one, except in the case of thirteen species which, in Table 1, are compared with those reported by Naumova (1953) from the Upper Devonian of the U.S.S.R.

In her 1953 report, Naumova presents numerous illustrations and descriptions of Upper Devonian spores. Unfortunately, the classification that she follows differs in many respects from that of Potonié and Kremp as well as from that of Schopf, Wilson and Bentall. The genera recognized are much broader, and include forms that are kept separate by other authors. Naumova's genus *Hymonozonotriletes*, for example, apparently includes both *Cirratriradites* and bladder spores such as *Endosporites*,



TEXT-FIGURE 2

Spores with a thick perispore of the subgroup *Archaeozonotriletes* Naumova: 1, spores from sporangium of *Sphenopteridium keilhani* Nath., from the Upper Devonian; 2–7, species of *Archaeozonotriletes*, from the Upper Devonian of the U.S.S.R. (after Naumova, 1953); ×200.

since its distinguishing feature is simply a spore that possesses a margin that is thin and filmy. An exact comparison with the spores present in the samples under discussion cannot, therefore, be made in several cases. However, Naumova's descriptions, and particularly her exact drawings, are such that a much closer similarity can be detected than is possible from the publications of Lang (1925), Thomson (1940), Hoeg (1942), and Radforth and McGregor (1954).

Of the thirteen species that resemble those described by Naumova, only three could actually be referred to by the names that she gave them. These are *Stenozonotriletes* sp. cf. *S. conspersus*, *Stenozonotriletes extensus* var. *major*, and *Leiozonotriletes* sp. cf. *Archaeozonotriletes primarius*. Although a fairly close similarity is apparent in the remaining ten species, they must be verified by a study of the type specimens before it will be justifiable to regard them as conspecific with Naumova's species. New names have been given to these ten species because it appears unlikely that the author can obtain Naumova's type specimens.

The spore assemblage of the West Gore sample, which is provisionally regarded as belonging to the Horton Bluff formation, undoubtedly has a Devonian aspect. This is particularly true because of the presence of spores that possess a thick perispore, such as *Leiozonotriletes*, n. gen., and *Spinozonotriletes*, n. gen. This is a feature that Naumova regards as characteristic of Devonian spores; it is abundantly represented in her Upper Devonian material from the U.S.S.R. In this material, Naumova recognized two genera that have this peculiar characteristic: *Archaeozonotriletes* Naumova, 1953, to which no less than sixty-one species were assigned, and *Lophozonotriletes* Naumova, 1953, which includes nineteen species. The new genera *Leiozonotriletes* and *Spinozonotriletes*, recognized in this report, may have been included in Naumova's genus *Archaeozonotriletes*, of which an illustration is given in text-figure 2. The reason for separating these two genera instead of using the name *Archaeozonotriletes* is explained in the systematic spore descriptions.

Another Devonian characteristic is the abundant occurrence of almost smooth, simple, trilete spores of the type of *Punctatisporites* Potonié and Kremp, 1954, or *Calamospora* Schopf, Wilson and Bentall, 1944. These spores comprise 68 per cent of the West Gore assemblage. Similar types are said to occur, sometimes quite profusely, in the Middle Devonian of Estonia (Thomson, 1940) and in the Old Red Sandstone of Scotland (Lang, 1925).

Although Devonian characteristics are observed in the spores of the Horton Bluff formation, some typical Devonian spores, such as the genera *Retusotriletes* Naumova, 1953, and in particular *Archaeotriletes* Naumova, 1953, were not found. The genus *Archaeotriletes* comprises spores with long spines ending in grapnel-like bifurcations or enlargements, which are similar to the spores of modern water ferns of the type of *Azolla* (Naumova, 1953). They have been noted in almost all Devonian strata whose spores have been examined. Quite similar in construction, but without the characteristic grapnel-like bifurcations, are the spores assigned to *Spinozonotriletes uncatus*, n. sp., which represent 2 per cent of the West Gore sample and were also noted in the sample from Blue Beach.

In conclusion, it may be said that the spore assemblage noted in the two samples examined indicates a continuation of the Upper Devonian flora into the lower portion of the Lower Carboniferous. A distinct floral break between the two systems does not appear to be represented, a conclusion that was also reached by Jongmans and others on the basis of the megaflora. Jongmans (1952, p. 18) states:

"It is a well known fact that there is no sharp separation between the lower part of the Mississippian and the upper part of the Devonian. Botanically, it might even be more reasonable to unite by a transition series the Upper Devonian with the lower part of the Mississippian. This transition contains a flora which I name the *Lepidodendropsis-Cyclostigma-Triphyllopteris* flora. Floras of this type are known all over the world: Peru, United States, Europe, Egypt, China, etc., and show a remarkable uniformity."

SYSTEMATIC SPORE DESCRIPTIONS

In the following descriptions, the types are identified as follows: "M" refers to the maceration number; the position on the slide is indicated by the instrument settings of the Leitz Dialux microscope.

Genus LEIOTRILETES (Naumova, 1937)
Potonié and Kremp, 1954

Leiotriletes notatus Hacquebard, **sp. nov.**
Plate 1, figures 1–2

Description: Spores radial, trilete; proximal outline subtriangular with straight or slightly convex sides and bluntly pointed corners; trilete sutures broad, lips raised, approximately equal spore radius; surface smooth; spore coat 2 microns thick; diameter 41–54 microns (on seven specimens).

Holotype: M 101, Slide 1, at 45.8 by 95.9 Dialux.

Remarks: Most specimens are folded in peculiar fashion, as is illustrated in plate 1, figure 2.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Leiotriletes sp. A
Plate 1, figures 3–4

Description: Spores radial, trilete; proximal outline subtriangular with concave sides and broadly rounded corners; trilete distinct, lips moderately developed, three-fourths spore radius; surface finely infragranulose, slightly darker in contact areas; spore coat 1.5 microns thick; diameter 47 microns (on two specimens).

Hypotypes: M 101, Slide 10, at 26.8 by 98 Dialux; and M 101, Slide 6, at 32.5 by 94.4 Dialux.

Remarks: This species resembles *Leiotriletes adnatus* (Kosanke, 1950) Potonié and Kremp, 1955, but is 7 microns larger. Not enough specimens were found to extend the size range of *Leiotriletes adnatus* to include *Leiotriletes* sp. *A*.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Genus PUNCTATISPORITES (Ibrahim, 1933) Potonié and Kremp, 1954

Punctatisporites debilis Hacquebard, **sp. nov.**
Plate 1, figures 5–6

Description: Spores radial, trilete; outline circular to subcircular; trilete area usually split open and folded, rays one-half to two-thirds spore radius; surface finely infragranulose (peppery); spore coat thin, about 1 micron thick; arcuate compression folds common, no preferred orientation; diameter 41–58 microns (on fifteen specimens).

Holotype: M 101, Slide 1, at 34.2 by 115 Dialux.

Remarks: This species resembles Species V B of Thomson (1940) from the Middle Devonian of Estonia.

Occurrence: Horton Group, Nova Scotia, West Gore and Blue Beach samples.

Punctatisporites irrasus Hacquebard, **sp. nov.**
Plate 1, figures 7–8

Description: Spores radial, trilete; form originally spherical; trilete sutures usually narrow but occasionally broad, lips raised, rays not always straight, one-half to two-thirds spore radius; surface finely infragranulose (peppery); spore coat 1.5–2 microns thick; arcuate compression folds often present and of major proportions; diameter 67–83 microns (on twenty specimens).

Holotype: M 101, Slide 4, at 32.2 by 96 Dialux.

Remarks: This species resembles Type D of Lang (1925) from the Old Red Sandstone of Scotland.

Occurrence: Horton Group, Nova Scotia, West Gore and Blue Beach samples.

Punctatisporites? limbatus Hacquebard, **sp. nov.**
Plate 1, figures 9–11

Description: Spores radial, trilete; subcircular to oval in proximal view, form originally spherical; trilete simple, sutures usually broad, sometimes split open, one-half to two-thirds spore radius; surface finely infragranulose; spore coat thin, about 1–1.5 microns thick, often torn in polar region; large, subcircular contact(?) areas are represented by thinner portions of spore coat; at equator spores have smooth collar or seam that may vary in width from 4–8 (12) microns on same specimen, but in thickness does not exceed or only slightly exceeds combined thicknesses of proximal and distal walls; arcuate compression folds often present; diameter 111–206 microns (on fifteen specimens).

Holotype: M 101, Slide 9, at 26.8 by 94.8 Dialux.

Remarks: The collar or seam at equator is regarded as a limbus; it is double-layered and represents an area where proximal and distal walls have remained in contact with each other. A similar feature is known in bladder spores, where the function of the limbus is thought to be one of keeping the bladder extended like a screen; the large size-range and thin exine of *Punctatisporites? limbatus* may similarly explain the presence of a limbus. This species is provisionally included with *Punctatisporites*, because of relatively long rays and distinct structure, but the presence of contact(?) areas may warrant assignment to the genus *Calamospora*; in neither genus has the presence of a limbus been reported. The species shows a general resemblance to Type C of Lang (1925) from the Old Red Sandstone of Scotland, and to Species III C of Thomson (1940) from the Middle Devonian of Estonia, as well as to *Calamospora?* sp. of Hoffmeister, Staplin and Malloy (1955*a*, pl. 1, fig. 11), from the Upper Devonian of Alberta.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Punctatisporites planus Hacquebard, **sp. nov.**
Plate 1, figure 12

Description: Spores radial, trilete; circular to subcircular in proximal view; trilete simple, two-thirds to three-fourths spore radius; surface smooth to very slightly infragranulose; spore coat 2 microns thick; occasionally one major compression fold; diameter 50–64 microns (on twelve specimens).

Holotype: M 101, Slide 4, at 31.2 by 96.3 Dialux.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Punctatisporites solidus Hacquebard, **sp. nov.**
Plate 1, figure 13

Description: Spores radial, trilete; roundly triangular in proximal view; trilete distinct, one ray occasionally longer than the other two, lips raised, two-thirds spore radius; surface smooth to very finely infrapunctate; spore coat 3–4 microns thick, appearing at equator as "limbus-like" margin or pseudo-rim; diameter 50–64 microns (on four specimens).

Holotype: M 101, Slide 5, at 46 by 110.9 Dialux.

Remarks: This species resembles Species V A of Thomson (1940) from the Middle Devonian of Estonia.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Punctatisporites viriosus Hacquebard, **sp. nov.**
Plate 1, figure 14

Description: Spores radial, trilete; outline circular to subcircular, generally proximo-distally oriented; trilete distinct, lips low and bordered by single row of minute pits that may be noted after careful focussing, sutures occasionally broad, one-half to two-thirds spore radius; surface essentially smooth to slightly rough, some speci-

mens show slightly darker colour in contact areas; spore coat 2.5–3 microns thick; small arcuate compression folds occasionally present; diameter 68–83 microns (on twelve specimens).

Holotype: M 101, Slide 1, at 48.4 by 112.9 Dialux.

Remarks: This species resembles *Punctatisporites? callosus* Hoffmeister, Staplin and Malloy, 1955*b*, but is larger and has a lip development.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Genus Cyclogranisporites Potonié and Kremp, 1954

Cyclogranisporites naevulus Hacquebard, **sp. nov.**
Plate 1, figure 15

Description: Spores radial, trilete; outline circular, generally proximo-distally oriented; trilete usually not distinct, less than one-half spore radius; ornamentation very finely granulose (peppery), grana barely visible at margin; slightly lighter-coloured contact areas are present, and vague line encircles trilete; spore coat 3–4 microns thick, appearing at equator as "limbus-like" margin or pseudo-rim; diameter 60–90 microns (on eleven specimens).

Holotype: M 101, Slide 10, at 39.7 by 111 Dialux.

Remarks: This species resembles *Leiotriletes atavus* Naumova, 1953, from the Upper Devonian of the U.S.S.R. However, in *Leiotriletes atavus* the margin is smooth and the diameter is smaller, but contact areas and length of rays appear to be very similar to those in *Cyclogranisporites naevulus*.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Cyclogranisporites sp. cf. **C. pressoides**
Potonié and Kremp, 1955
Plate 1, figure 16

Description: Spores radial, trilete; subcircular to broadly roundly triangular in proximal view; trilete simple, sutures occasionally broad, extending to equator or nearly so; ornamentation finely granulose, margin slightly sinuous or minutely notched; spore coat thin, about 1 micron thick; one arcuate compression fold generally present; diameter 27–34 microns (on twelve specimens).

Hypotype: M 101, Slide 1, at 45.2 by 111.2 Dialux.

Remarks: This species is similar to *Cyclogranisporites pressoides* Potonié and Kremp, 1955, but is from 2 to 9 microns larger. It is present in the Westphalian of the Ruhr and Saar basins.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Cyclogranisporites sp. A
Plate 1, figure 17

Description: Spore radial, trilete; broadly roundly triangular to subcircular in proximal view; trilete distinct, lips slightly raised, narrow taper-pointed folds accompany rays and extend beyond them, rays are two-thirds spore radius; surface finely granulose (peppery), minute grana visible at margin; spore coat 4–5 microns thick, appearing at equator as "limbus-like" margin or pseudo-rim; diameter 146 × 152 microns (one specimen only).

Hypotype: M 101, Slide 4, at 29.2 by 101.9 Dialux.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Genus Lophotriletes (Naumova, 1937) Potonié and Kremp, 1955

Lophotriletes sp. A
Plate 1, figure 18

Description: Spores radial, trilete; roundly triangular in proximal view; trilete not distinct, approximately three-fourths spore radius; exine has minute cones, not closely set, and protruding at margin; cones do not exceed 2 microns in length and stand 1.5–2 microns apart; spore coat 1.5 microns thick; diameter 33–35 microns (on three specimens).

Hypotype: M 101, Slide 1, at 28.6 by 104.9 Dialux.

Remarks: This species resembles *Acanthotriletes parvus* Naumova, 1953, from the Upper Devonian of the U.S.S.R. Not enough specimens were found to warrant a definite assignment.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Genus Acanthotriletes (Naumova, 1937) Potonié and Kremp, 1954

Acanthotriletes horridus Hacquebard, **sp. nov.**
Plate 1, figure 20

Description: Spores radial, trilete; subcircular to oval in proximal view; trilete distinct, lips raised, extending to equator or nearly so; ornamentation finely granulose (peppery) and spinose; spines arranged more or less in concentric rows, closely set at equator and more widely spaced in polar regions; spines are long, fairly heavy at base and have on occasion very slender and sharp tips that may be bent over; spines 12–23 (29) microns long, 5–8 microns wide at base; approximately forty-five spines occur at equator; spore coat 4–6 microns thick at equator, but possibly thinner in center; diameter 124–170 microns, exclusive of spines (on three specimens only).

Holotype: M 101, Slide 1, at 40.3 by 113 Dialux.

Remarks: This species resembles *Apiculati* sp. of Hoeg (1942, pl. 31, figs. 14–15), from the Middle(?) Devonian of Spitzbergen.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Acanthotriletes sp. A
Plate 1, figure 19

Description: Spore radial, trilete; outline subcircular; trilete simple, sutures broad, extending to equator; ornamentation spinose; spines 1.5–2.5 microns long and 2–3 microns apart; sixteen spines occur at equator; spore coat 1.5 microns thick; diameter 33 × 39 microns (one specimen only).

Hypotype: M 101, Slide 1, at 46.4 by 102 Dialux.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Genus RAISTRICKIA
(Schopf, Wilson and Bentall, 1944)
Potonié and Kremp, 1954

Raistrickia ampullacea Hacquebard, **sp. nov.**
Plate 1, figures 21–22

Description: Spores radial, trilete; roundly triangular in proximal view; trilete simple, extending to equator or nearly so; ornamentation on distal side only, flask-shaped processes; processes up to 4 microns long, 2–3 microns wide at base, with truncated tops 1–1.5 microns wide; in plan view, when not bent over, processes appear as round warts with dark concentric area in center; processes are not very closely set, with enough room between them for others of about equal size; thirty-nine to fifty processes occur on exine surface, of which nine to fourteen are at equator; spore coat 1.5–2 microns thick; diameter 47–54 microns (on three specimens only).

Holotype: M 101, Slide 1, at 37.7 by 95.3 Dialux.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Raistrickia baculosa Hacquebard, **sp. nov.**
Plate 1, figures 23–24

Description: Spores radial, trilete; circular in proximal view; trilete not distinct, from one-half to two-thirds spore radius; ornamentation baculae and rounded cones, fairly closely set; baculae generally as wide as they are long, but in some instances the width may be almost twice as much as the length; baculae and cones differ greatly in size on same specimen; they are 3–8 microns long and 3–10 microns wide at base; some baculae are truncated and may possess minute papillae at top; spore coat 2–4 microns thick; diameter 72–107 microns (on nine specimens).

Holotype: M 101, Slide 6, at 38.5 by 105 Dialux.

Remarks: This species resembles *Raistrickia saetosa* (Loose) Schopf, Wilson and Bentall, 1944, from the Westphalian of the Ruhr, but has a larger size-range and baculae that are shorter and wider.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Raistrickia clavata Hacquebard, **sp. nov.**
Plate 1, figure 25

Description: Spore radial, trilete; subtriangular with convex sides and rounded corners in proximal view; trilete distinct, two-thirds spore radius; ornamentation large club-shaped projections, relatively closely set; projections 7–8.5 microns long, 3–4 microns wide at base, 6–7 microns wide at top, where they are thickened; nine projections occur at equator; spore coat 2 microns thick; diameter 58 × 62 microns (one specimen only).

Holotype: M 101, Slide 7, at 31.4 by 113.4 Dialux.

Remarks: The triangular shape and larger club-shaped projections, of which only nine occur at the margin, differentiate this species from *Raistrickia pistillata*, sp. nov.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Raistrickia? gibberosa Hacquebard, **sp. nov.**
Plate 2, figure 1

Description: Spore radial, trilete; roundly triangular in proximal view; trilete obscure, probably extending to equator; ornamentation on distal side only, large rounded and truncated tubercles 4–14.4 microns wide, 4–8 microns high; there are thirty-three tubercles present, of which eleven occur at equator; tubercles fairly widely set, with enough room between them for others of about equal size; spore coat very thin, about 1 micron thick, possibly a result of the state of preservation; diameter 76 × 76 microns (one specimen only).

Holotype: M 101, Slide 6, at 27.8 by 100 Dialux.

Remarks: This spore resembles Type J5 of Radforth and McGregor (1954), from the Middle Devonian of the Gaspé Peninsula.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Raistrickia pistillata Hacquebard, **sp. nov.**
Plate 2, figure 2

Description: Spores radial, trilete; circular to subcircular in proximal view; trilete often obscured by ornamentation, sutures may be broad, two-thirds spore radius; ornamentation closely set pila-like to club-shaped projections with expanded heads, and rounded

cones 3–6 (7) microns long, 1.5–3 microns wide at base, 3–5 (7) microns wide at top; projections vary in size and shape on same specimen; approximately fifty to seventy projections on exine surface, of which eighteen to twenty-one occur at equator; spore coat 2 microns thick; diameter 72–84 microns (on eight specimens).

Holotype: M 101, Slide 5, at 43.7 by 96 Dialux.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Raistrickia sp. A
Plate 2, figure 3

Description: Spores radial, trilete; subcircular to oval in proximal view; trilete not distinct, two-thirds spore radius; ornamentation on distal side only, processes that vary in size and shape: baculae up to 4 microns long and 2 microns wide, blunt cones 3 microns long and 2 microns wide, flask-shaped processes up to 4 microns long; processes not very closely set, with here and there enough room between them for others of about equal size; on exine surface thirty-nine to forty-two processes, of which sixteen or seventeen occur at equator; spore coat 2 microns thick; diameter 45–54 microns (on two specimens only).

Hypotype: M 101, Slide 7, at 26.6 by 112.8 Dialux.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Genus VERRUCOSISPORITES (Ibrahim, 1933)
Potonié and Kremp, 1954

Verrucosisporites papulosus Hacquebard, **sp. nov.**
Plate 2, figures 4–5

Description: Spores radial, trilete; originally spherical in shape, usually oval in proximal view; trilete generally not distinct, may be split open, two-thirds spore radius; ornamentation round and elongated warts, somewhat loosely set (negative reticulum is not represented); warts 1–3 (4) microns in diameter, 1.5–2 microns high at margin; approximately forty-eight warts occur at equator; spore coat thin, about 1.5 microns thick; arcuate compression-folds may be present; diameter 50–62 microns (on nine specimens).

Holotype: M 101, Slide 1, at 47.2 by 108.4 Dialux.

Remarks: Although some of the protuberances at equator are somewhat bluntly cone-shaped, those on exine surface indicate that warts and not cones are represented. The species is similar to *Verrucosisporites verrucosus* Ibrahim, 1933, but the warts are not as closely set and the size-range is smaller. It also resembles Type H'6 of Radforth and McGregor (1954), from the Middle Devonian of the Gaspé Peninsula.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Genus MICRORETICULATISPORITES (Knox, 1950)
Potonié and Kremp, 1954

Microreticulatisporites sp. A
Plate 2, figure 6

Description: Spore radial, trilete; subcircular in outline; trilete area split open, rays approximately one-half spore radius; exine microreticulate; lacunae round and elongated in shape, 1–3 (4) microns in diameter, (1) 2–4 microns apart; spore coat 1.5–2 microns thick; diameter 50 × 58 microns (one specimen only).

Hypotype: M 101, Slide 5, at 46.4 by 108.3 Dialux.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Genus RETICULATISPORITES (Ibrahim, 1933)
Potonié and Kremp, 1954

Reticulatisporites sp. cf. **R. reticulatus** Ibrahim, 1932
Plate 2, figure 7

Description: Spores radial, trilete not observed; circular to weakly polygonal in outline; ornamentation reticulate, margin bastion-like due to muri; luminae fairly deep, 11–20 microns in diameter; muri 3 microns wide, slightly protruding past margin; there are about sixteen luminae on one side of illustrated specimen, and about sixteen muri at equator; border between muri at equator thin, but not membranous; luminae are finely infragranulose and more or less polygonal in outline; diameter 90–93 microns (on three specimens only).

Hypotype: M 101, Slide 2, at 28.4 by 104.4 Dialux.

Remarks: This species differs only slightly from *Reticulatisporites reticulatus* Ibrahim, 1932. The margin is not truly membranous, and the luminae are not punctate, but granulose.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Genus CONVOLUTISPORA
Hoffmeister, Staplin and Malloy, 1955

Convolutispora flexuosa forma **major** Hacquebard, **sp. nov.**
Plate 2, figures 8–9

Description: Spores radial, trilete; circular to subcircular in proximal view; trilete usually obscured by ornamentation, occasionally split open, rays slightly less than one-half spore radius; ornamentation thick, irregular, partly anastomosing ridges of variable width and height and protruding past equator; ridges 6–10 (18) microns wide, 8–12 (16) microns high at margin; lacunae 5–18 microns in diameter; spore coat, except for ridges, not very thick; diameter 124–255 microns (on twenty specimens).

Holotype: M 101, Slide 1, at 36.7 by 111.5 Dialux.

Remarks: This species resembles *Convolutispora* sp. of Hoffmeister, Staplin and Malloy (1955*a*), from the Upper Devonian of Alberta, but is considerably larger than the specimen illustrated by those authors in plate 1, figure 2.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Convolutispora flexuosa forma **minor** Hacquebard, **sp. nov.**
Plate 2, figure 10

Description: Spores radial, trilete; subcircular to oval in outline; trilete obscured by ornamentation; exine has thick, irregularly winding ridges that protrude past margin; ridges 4–6 microns wide; lacunae (3) 4–8 microns in diameter; spore coat probably fairly thick; diameter 72 microns (on two specimens only).

Holotype: M 101, Slide 9, at 32.5 by 94.9 Dialux.

Remarks: This species is similar to *Convolutispora flexuosa* forma *major*, but is considerably smaller.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Genus Lycospora (Schopf, Wilson and Bentall, 1944) Potonié and Kremp, 1954

Lycospora torulosa Hacquebard, **sp. nov.**
Plate 2, figure 11

Description: Spores radial, trilete; broadly roundly triangular in proximal view; trilete obscured by ornamentation, rays extending to rim; central area medium to coarsely granulose, with some of the grana reaching wart-like dimensions of up to 3 microns in diameter; ornamentation is somewhat variable as to coarseness between different specimens; rim 3–5(6) microns wide, cuneiform in cross-section; diameter 41–53 microns (on nine specimens).

Holotype: M 101, Slide 2, at 27.5 by 104.3 Dialux.

Remarks: This species resembles *Stenozonotriletes fumanus* Naumova, 1953, from the Upper Devonian of the U.S.S.R., but has a slightly larger size-range and probably somewhat coarser ornamentation.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Genus **Vallatisporites** Hacquebard, **gen. nov.**

Description: Spores radial, trilete; proximal view convexly subtriangular; trilete not always distinct, rays extending into flange; central body thin with well defined margin, subcircular to broadly roundly triangular in outline; perispore extends beyond body margin and thickens into narrow "ridge," characterized by single row of pits (visible in high focus), from which it tapers to equator in the form of a flange; area between body margin and perisporal "ridge" may vary from a few microns, in which case it appears like a groove, to as much as 8 microns, becoming rampart-like in appearance; central area covered with grana, small cones or warts; flange may contain rodlets and cones radiating from perisporal "ridge," and gradually becomes thinner and more translucent toward periphery; diameter 55–84 microns, on four species, here described.

Genotype: Vallatisporites vallatus Hacquebard, sp. nov.

Remarks: This genus resembles *Densosporites* in construction of equatorial portion; it differs in possessing a well defined central body that is separated from the equatorial portion by a distinct groove or rampart-like area, from which the name *Vallatisporites* is derived. This area is also present in several spores reported by Naumova (1953) from the Upper Devonian of the U.S.S.R. They are included in the subgroup *Hymonozonotriletes* Naumova, 1937, which in the 1953 report is described as follows: Spores with a membranous perispore that projects at the margin in the form of a membranous flange. As explained previously, the present author regards this subgroup as too broad to be used as a genus in the classification of Potonié and Kremp (1954), which is followed in this report. The presence of the single row of pits near the inner margin of the equatorial portion is a feature that is also reported in the subgroup *Trematozonotriletes* Naumova, 1937. However, the brevity of the description makes comparison with spores here assigned to *Vallatisporites* very difficult. With regard to *Trematozonotriletes*, Potonié and Kremp (1956) mention that this subgroup can probably be included in the genus *Densosporites*, and that, at least at present, it is not necessary to recognize it as a separate genus. The presence of a groove or rampart-like area, as well as the single row of pits, common to several types, is considered by the author sufficiently diagnostic to separate these spores from *Densosporites*.

Vallatisporites vallatus Hacquebard, **sp. nov.**
Plate 2, figure 12

Description: Spores radial, trilete; convexly subtriangular in proximal view; trilete usually distinct, lips slightly raised, extending to equator or nearly so; central body thin, margin well defined, often folded; in central area, perispore has minute grana and small cones, 1–2 microns in diameter, 2–3 microns apart; perisporal extension with rampart-like inner part, up to 8 microns wide, and flange-like outer part, 6–10 microns wide; where the two parts meet, perispore is thickened and contains a single row of pits, visible in high focus; flange-like portion has minute cones and small grana, membranous border, and finely toothed outer margin; diameter 60–70 microns, body 35–41 microns (on five specimens).

Holotype: M 101, Slide 5, at 39.6 by 106.3 Dialux.

Remarks: This species resembles *Hymonozonotriletes meonacanthus* Naumova, 1953, from the Upper Devonian of the U.S.S.R., but its diameter is 10 microns less.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Vallatisporites verrucosus Hacquebard, **sp. nov.**
Plate 2, figure 13

Description: Spores radial, trilete; convexly subtriangular in proximal view; trilete not always distinct, extending to equator or nearly so; central body thin, margin well defined, often folded; in central area, perispore is verrucose, with warts from 2–4(5) microns in diameter; perisporal extension with narrow, groove-like inner part, only 1 micron wide, and flange-like outer part 6–10 microns wide; where the two parts meet, perispore is thickened and contains a single row of pits, visible in high focus; flange-like portion is granulose, has membranous border and slightly undulating outer margin; diameter 55–64 microns, body 41–47 microns (on five specimens).

Holotype: M 101, Slide 1, at 44.6 by 112.1 Dialux.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Vallatisporites sp. A
Plate 2, figure 14

Description: Spore radial, convexly subtriangular in proximal view; trilete not positively identified; central body thin, margin well defined, folded; in central area, perispore has minute grana and small cones, 2–3 microns in diameter and 3–4 microns apart; perisporal extension with narrow, groove-like inner part, only 1.5 microns wide, and flange-like outer part, 12–14 microns wide; flange thick, with radiating rodlets and single row of pits (visible in high focus) near inner margin; outer portion of flange membranous, with minute cones, widely set; outer margin very finely toothed to irregularly undulating; diameter 68 × 68 microns, body 39 × 41 microns (one specimen only).

Hypotype: M 101, Slide 4, at 29 by 113.7 Dialux.

Remarks: This species resembles *Hymonozonotriletes deliquescens* Naumova, 1953, from the Upper Devonian of the U.S.S.R., but the cones appear to be smaller, and the trilete is not positively represented.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Vallatisporites sp. B
Plate 2, figure 15

Description: Spore radial; convexly subtriangular in proximal view; trilete not positively identified; central body thin, margin well defined, folded; in central area, perispore has grana and warts, 1–4 microns in diameter, closely set; perisporal extension with rampart-like inner part, 3–4 microns wide, and flange-like outer part, 12–18 microns wide; flange thick, with radiating cone-shaped darker portions and a single row of pits (visible in high focus) near inner margin; outer portion of flange membranous, irregularly ruffled; outer margin very finely toothed; diameter 80 × 84 microns, body 42 × 47 microns (one specimen only).

Hypotype: M 101, Slide 6, at 35 by 113.1 Dialux.

Remarks: In construction this species appears to be similar to *Hymonozonotriletes speciosus*, from the Upper Devonian of the U.S.S.R.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Genus **Stenozonotriletes** (Naumova, 1937), **emend.** Hacquebard

Description: Spores radial, trilete; triangular, subcircular or circular in proximal view; trilete not always distinct, rays long, at least three-fourths radius of central area; rim narrow, rounded (not cuneiform), surrounding central area like a tire around a wheel; ornamentation of central area infragranulose, punctate or smooth, rim essentially smooth to slightly rough; diameter 37 to 119 microns (on four species, here described).

Remarks: This genus differs from *Lycospora* (Schopf, Wilson and Bentall) Potonié and Kremp, 1954, in possessing a rounded rather than a cuneiform rim. In construction the rim is more like a "limbus" than like a true cingulum; it does not overlap the central area, which has a very regular (non-folded) margin. Two species present in the Horton samples are very similar to those described by Naumova (1953) and assigned by her to the subgroup *Stenozonotriletes*. This subgroup is defined as comprising spores without perispore and possessing a narrow rim. It probably includes the genus *Lycospora*, and in order to keep this genus separate, the author has emended Naumova's definition of *Stenozonotriletes*.

Stenozonotriletes sp. cf. **S. conspersus** Naumova, 1953
Plate 2, figure 16

Description: Spore radial, trilete; subtriangular with convex sides and rounded corners in proximal view; trilete not distinct, rays with low lips that extend to rim; central area finely infragranulose; rim smooth, 3–3.5 microns wide; diameter 35 × 37 microns (one specimen only).

Hypotype: M 101, Slide 5, at 31.6 by 94.4 Dialux.

Remarks: This spore is quite similar to *Stenozonotriletes conspersus* Naumova, 1953, from the Upper Devonian of the U.S.S.R., except that the low lips are not clearly indicated in Naumova's description.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Stenozonotriletes deltoides Hacquebard, **sp. nov.**
Plate 2, figures 17–18

Description: Spores radial, trilete; somewhat deltoid to broadly roundly triangular in proximal view; trilete distinct, lips raised, three-fourths radius of central area; central area smooth to finely infragranulose or punctate; rim smooth, 4–5(6) microns wide; spore coat thin, central portion often torn, diameter 74–119 microns (on seven specimens).

Holotype: M 101, Slide 2, at 31 by 98.9 Dialux.

Remarks: This species resembles Species III B of Thomson (1940), from the Middle Devonian of Estonia.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Stenozonotriletes extensus var. **major** Naumova, 1953
Plate 2, figures 19–20

Description: Spores radial, trilete; subcircular to very broadly roundly triangular in proximal view; trilete simple, three-fourths or more radius of central area, lips moderately developed in some specimens; central area finely infragranulose (peppery); rim essentially smooth to slightly rough, 4–5 microns wide; spore coat thin, central portion often torn; diameter 55–78 microns (on nineteen specimens).

Hypotypes: M 101, Slide 4, at 33.7 by 106.9 Dialux; M 101, Slide 10, at 27.9 by 93.2 Dialux.

Remarks: Because of corrosion of the central area, the trilete cannot always be observed. The species agrees closely with the description of *Stenozonotriletes extensus* var. *major*, from the Upper Devonian of the U.S.S.R., but extends the size range by 13 microns.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Stenozonotriletes? sp. cf. **Zonotriletes stenozonalis** Waltz, 1938, Hacquebard, **comb. nov.**
Plate 2, figure 21

Description: Spores radial, trilete; subcircular in proximal view; trilete indistinct, rays extend to rim or nearly so; central area finely infragranulose; rim slightly rough, 8–10 microns wide; spore coat thick and not very transparent; diameter 74–89 microns (on four specimens).

Hypotype: M 101, Slide 6, at 34.9 by 113.2 Dialux.

Remarks: This species is provisionally assigned to *Stenozonotriletes*. An overlap of the rim on the central area was not noted, but the specimens are all fairly opaque. A similar spore occurs in the South Nahanni River coal of western Canada, where it was assigned to the genus *Cincturasporites* Hacquebard and Barss, 1957, because an overlap was observed in that particular specimen (Hacquebard and Barss, 1957). It closely resembles *Zonotriletes stenozonalis* Waltz, 1938, from the Lower Carboniferous of the U.S.S.R.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Stenozonotriletes sp. A
Plate 2, figure 22

Description: Spores radial, trilete; subtriangular with straight sides and somewhat pointed corners in proximal view; trilete distinct, extending to rim; central area and rim smooth; inner margin of rim indicated by a distinct groove; rim 4 microns wide; spore coat fairly thick; diameter 43–53 microns (on two specimens only).

Hypotype: M 101, Slide 10, at 30.8 by 93.2 Dialux.

Remarks: This species resembles *Stenozonotriletes informus* Naumova, 1953, from the Upper Devonian of the U.S.S.R., but is 3–13 microns larger.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Genus **Leiozonotriletes** Hacquebard, **gen. nov.**

Description: Spores radial, trilete; subcircular or roundly triangular in proximal view; trilete obscure or distinct, may possess greatly developed triradiate ridges, rays long, two-thirds of or equal to body radius; central body outline not always distinct and often not conformable with equatorial outline; perispore thick, extending beyond body margin in the form of a relatively dense flange; perispore devoid of ornamentation (sculpture), but may possess structure such as infragranulations, punctations, etc.; equatorial margin therefore smooth or only slightly undulating; diameter 50–117 microns, on four species, here described.

Genotype: Leiozonotriletes insignitus Hacquebard, sp. nov.

Remarks: The genus *Leiozonotriletes* refers to spores that may all have been included in *Archaeozonotriletes* Naumova, 1953. A new and more restricted genus is erected because the author is of the opinion that Naumova's subgroup is too broad to be regarded as a form genus in the sense of Potonié and Kremp (1954). *Archaeozonotriletes* is described in the French translation of Naumova's 1953 publication as follows:

"Spores à périspore compacte, bien développée, saillante sur les bords en forme d'anneau. Surface de la périspore et de l'exine lisses, ou ornées de façons diverses: tubercules, épines, etc., qui différencient les espèces."

According to the principles of classification used by Potonié and Kremp (1954), different form genera can be separated from this subgroup on the basis of the ornamentation of the perispore; this has already been done on the basis of the ornamentation of the exospore, for example, in *Punctatisporites*, *Cyclogranisporites*, *Acanthotriletes*, etc. On this basis the genera *Leiozonotriletes* and *Spinozonotriletes* are here erected for types observed in the two Horton samples studied to date. More such genera can be separated from *Archaeozonotriletes*, but such forms have not yet been observed. In this con-

nection, it may be pointed out that Naumova excluded from *Archaeozonotriletes* those types that possess a thick perispore with relatively large tubercles, which she assigned to the subgroup *Lophozonotriletes*.

Leiozonotriletes insignitus Hacquebard, **sp. nov.**
Plate 3, figure 1

Description: Spores radial, trilete; ovoid in proximal view; trilete distinct, lips raised into prominent triradiate ridges up to 5 microns wide, rising toward apex of spore, extending to body margin; central body margin not always distinct, ovoid in outline; perispore thick, forming a flange of uneven width, slightly folded in portion overlying body; surface of perispore finely infragranulose-punctate to almost smooth; flange 12–21 microns wide on same specimen; diameter 103–144 microns, body 70–103 microns (on six specimens).

Holotype: M 101, Slide 5, at 42 by 97.8 Dialux.

Remarks: This species resembles *Archaeozonotriletes primarius* Naumova, 1953, from the Upper Devonian of the U.S.S.R., but has shorter rays and is 8–50 microns larger.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Leiozonotriletes meracus Hacquebard, **sp. nov.**
Plate 3, figures 2–3

Description: Spores radial, trilete; oval to subcircular in proximal view; trilete not distinct, thin rays extend to body margin; central body generally more rounded than equatorial outline, body wall thin, often folded; perispore fairly dense beyond body margin, where it forms a flange of uneven width, thin in portion overlying body; flange 4–10 microns wide on same specimen, possessing a narrow limbus at equator; perispore finely infragranulose to almost smooth except near body margin, where in some specimens it is microreticulate; diameter 50–67 microns, body 40–49 microns (on six specimens).

Holotype: M 101, Slide 7, at 19.8 by 102.1 Dialux.

Remarks: This species is similar to *Archaeozonotriletes purus* Naumova, 1953, but is 15–32 microns larger. It also resembles *Archaeozonotriletes compactus* var. *famenensis* Naumova, 1953, but in that species the flange is more granulose; it is also smaller, being only 40–45 microns in diameter. Both species occur in the Upper Devonian of the U.S.S.R.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Leiozonotriletes sp. cf. **Archaeozonotriletes primarius** Naumova, 1953, Hacquebard, **comb. nov.**
Plate 3, figure 4

Description: Spore radial, trilete; broadly roundly triangular in outline; trilete distinct, lips raised into prominent triradiate ridges, 6 microns wide, rising toward apex of spore, extending to body margin (four-fifths of spore radius); central body margin indistinct, more or less ovoid in outline; perispore very thick, forming flange of uneven width that varies between 5 and 10 microns; perispore finely infragranulose in portion overlying body, almost smooth beyond body margin; diameter 86.5 × 86.5 microns, body 67 × 68 microns (one specimen only).

Hypotype: M 101, Slide 1, at 46.3 by 112 Dialux.

Remarks: The prominent triradiate ridges resemble those known in *Cadiospora* Kosanke, 1950, but arcuate ridges are not represented. This spore has a thick perispore and closely resembles *Archaeozonotriletes primarius* Naumova, 1953, from the Upper Devonian of the U.S.S.R., both in the strong development of the trilete and in the diameter, which is 80–95 microns.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Leiozonotriletes sp. A
Plate 3, figure 5

Description: Spores radial, trilete; roundly triangular in proximal view; trilete distinct, two-thirds of body radius; central body margin distinct, surface infragranulose; perispore thin, transparent and folded where it overlies body, somewhat thicker and more compact beyond body margin, where it forms a narrow flange; flange 8–10 microns wide; perispore smooth; diameter 93 to 117 microns, body 78–100 microns (on two specimens only).

Hypotype: M 101, Slide 5, at 32.8 by 109.8 Dialux.

Remarks: In this species the perispore is thinner than in other species assigned to *Leiozonotriletes*; however, since it forms a fairly compact narrow flange, it is not regarded as a bladder-type spore.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Genus **Spinozonotriletes** Hacquebard, **gen. nov.**

Description: Spores radial, trilete; roundly triangular or subcircular in proximal view; trilete obscure or distinct, lips not represented or very prominent, rays extending to body margin or reaching equator; central body margin not distinct, conformable to equatorial outline; perispore very thick, extending beyond body margin in the form of a dense flange; perispore contains well developed spines that radiate from body margin and equator but also occur more randomly over entire perispore surface; except for spines, perispore is smooth or granulose; diameter 82–148 microns, on two species, here described.

Genotype: Spinozonotriletes uncatus Hacquebard, sp. nov.

Remarks: This genus was separated from the subgroup *Archaeozonotriletes* Naumova, 1953, on the same basis as *Leiozonotriletes* Hacquebard, gen. nov.

Spinozonotriletes tenuispinus Hacquebard, **sp. nov.**
Plate 3, figures 6–7

Description: Spores radial, trilete; subcircular to broadly roundly triangular in outline; trilete indistinct, extending to body margin; central body margin obscure, fairly dense; perispore thick, forming a dense flange 14–17 microns wide; perispore surface finely granulose and spinose; spines arranged in concentric rows, one at equator and another at body margin, where they are closely set; only a few spines in contact areas; spines long and slender, 4–16 microns long, 2–4 microns wide at base, sharply pointed with tips often bent over; diameter 103–113 microns (exclusive of spines), body 78–86 microns (on four specimens).

Holotype: M 101, Slide 7, at 33.3 by 94.3 Dialux.

Remarks: This species resembles Type D of Hoffmeister, Staplin and Malloy (1955*b*), from the Upper Mississippian of the United States, but that type is described inadequately for detailed comparison.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Spinozonotriletes uncatus Hacquebard, **sp. nov.**
Plate 3, figures 8–10

Description: Spores radial, trilete; convexly subtriangular in proximal view; trilete distinct, rays flange-like, extending to equator; central body margin not distinct, fairly dense; perispore thick, forming a dense flange 12–25 microns wide; perispore surface smooth but carrying stout spines that radiate from body margin and from equator but also occur more randomly and less frequently in center on both proximal and distal sides; spines 4–15 (20) microns long, 3–6 microns wide at base, sharply pointed, tips often bent over; about twenty-one spines occur at equator; diameter 82–148 microns (exclusive of spines), body 62–103 microns (on nine specimens).

Holotype: M 101, Slide 1, at 40.8 by 97.3 Dialux.

Remarks: In construction this species is similar to Type G of Lang (1925) and to *Archaeozonotriletes aduncus* Naumova, 1953, both reported from Devonian strata. However, the characteristic grapnel-like thickening at the end of the spines is not present in the species described here, and although these spores are probably related, they are not the same.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Genus **Lepidozonotriletes** Hacquebard, **gen. nov.**

Description: Spores radial, trilete; roundly triangular in proximal view; trilete distinct, rays flange-like, extending to body margin and beyond into the pseudoflange; central body margin obscured by ornamentation, perispore thick, with rows of imbricating, plate-like, scalloped units, extending beyond body margin in the form of a pseudoflange; these units also occur on distal surface but are not as dense; they are not present in contact areas; diameter 103–195 microns, on one species only, here described.

Genotype: Lepidozonotriletes aculeatus Hacquebard, sp. nov.

Remarks: This genus is considered to have a status similar to that of *Leiozonotriletes* and *Spinozonotriletes*. Forms that are similar were not reported by Naumova (1953).

Lepidozonotriletes aculeatus Hacquebard, **sp. nov.**
Plate 3, figures 11–12

Description: Spores radial, trilete; roundly triangular in proximal view; trilete distinct, rays flange-like, extending to body margin and beyond into the pseudoflange; central body margin obscured by ornamentation; perispore thick, with two or three rows of imbricating sculpture elements that form a pseudoflange; elements consist of plate-like, scalloped units, fused at base and with small spines at top (present in well preserved specimens only); this ornamentation also present on distal surface, but is not as dense as on equator; it is not present in contact areas, which are finely granulose; pseudoflange 13–30 microns wide; scalloped units 20 microns high and 20 microns wide at base in largest specimens; spines 2–3(8) microns long; diameter 103–195 microns, body 72–144 microns (on sixteen specimens).

Holotype: M 101, Slide 4, at 45.2 by 110.6 Dialux.

Remarks: In some specimens the rays are not as distinctly flange-like as in the holotype, but otherwise the characteristics are the same (see pl. 3, fig. 12).

Occurrence: Horton group, Nova Scotia, West Gore sample.

Genus Endosporites Wilson and Coe, 1940

Endosporites angustus Hacquebard, **sp. nov.**
Plate 3, figure 13

Description: Spores radial, trilete; proximal outline subcircular; trilete obscured by folding of bladder, lips slightly developed, one-half to two-thirds spore radius; central body dense, margin distinct, conformable to equatorial outline; bladder thin, strongly folded over body, extending 7–12 microns beyond body margin; body probably smooth, bladder finely infragranulose (peppery); diameter 110–165 microns, body 100–150 microns (on three specimens only).

Holotype: M 101, Slide 9, at 25.5 by 98.3 Dialux.

Remarks: This species resembles *Hymonozonotriletes platyrugosus* Naumova, 1953, from the Upper Devonian of the U.S.S.R., but has shorter rays and is 30–85 microns larger.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Endosporites macromanifestus Hacquebard, **sp. nov.**
Plate 3, figures 14–15

Description: Spores radial, trilete; convexly subtriangular in proximal view; trilete distinct, rays with flanges (bladder folds) to equator or nearly so; central body thin, margin distinct, conformable to equatorial outline; bladder thin, strongly folded, particularly over body, extending 20–39 microns beyond body margin; body exine probably levigate, bladder very finely infragranulose to almost smooth, without inner reticulation; limbus not present; diameter 112–173 microns, body 54–98 microns (on twelve specimens).

Holotype: M 101, Slide 2, at 24.3 by 99.1 Dialux.

Remarks: This species resembles Type A of Lang (1925), which is very common in the Old Red Sandstone of Scotland.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Endosporites micromanifestus Hacquebard, **sp. nov.**
Plate 3, figure 16

Description: Identical with *Endosporites macromanifestus* but smaller, and bladder generally more distinctly infragranulose; width of bladder beyond central body 10–18(24) microns; diameter 58–100 microns, body 37–67 microns (on fourteen specimens).

Holotype: M 101, Slide 10, at 36.1 by 101.6 Dialux.

Remarks: This species is probably very similar to *Hymonozonotriletes variabilis* Naumova, 1953, from the Upper Devonian of the U.S.S.R. The subgroup *Hymonozonotriletes*, however, includes both bladder spores and flange spores of the type of *Cirratriradites*, and it is therefore impossible to know whether or not *Hymonozonotriletes variabilis* possesses a bladder, although the illustration suggests that it does. The species described here could also be similar to *Zonotriletes elegans* Waltz, 1938, but here again, it is not known whether a bladder or a flange is represented. *Zonotriletes elegans* has been reported from the Lower Carboniferous of the U.S.S.R.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Genus **Grandispora** Hoffmeister, Staplin and Malloy, 1955

Description: Hoffmeister, Staplin and Malloy (1955*b*) describe this genus as follows: "Spores radial, trilete; central body enclosed by a bladder, both subcircular; central body levigate(?); possibly punctate or granulose; bladder wall punctate to granulose, possibly levigate, with prominent scattered spines; trilete rays weak, simple, apparently extend to edge of central body; central body wall only slightly thicker than the bladder wall, translucent."

Genotype: Grandispora spinosa Hoffmeister, Staplin and Malloy, 1955.

Remarks: The authors state that the spinose bladder distinguishes this genus from *Endosporites*; only one species, the genotype, was assigned to this genus. This species occurs in the Upper Mississippian of the United States; it measures 100–143 microns in diameter. The Horton samples contain two types that may be included in *Grandispora*, giving the genus a size-range of 62–143 microns.

Grandispora echinata Hacquebard, **sp. nov.**
Plate 3, figure 17

Description: Spores radial, trilete; central body enclosed by bladder, both subcircular to broadly roundly triangular in proximal view; trilete generally not distinct, rays simple, extending to body margin; central body fairly thin, margin well defined; bladder thin, folded over body, extending 4–9(12) microns beyond body margin, narrow limbus at equator; body exine probably levigate; bladder has small cones and spines, 1.5–2(4) microns long and 2–6 microns apart; diameter 62–93 microns, body 47–70 microns (on twelve specimens).

Holotype: M 101, Slide 2, at 21 by 103.9 Dialux.

Remarks: This species is assigned to the genus *Grandispora* because a spinose bladder spore is represented. However, the diameter, as well as the length of the spines, is considerably below that of the genotype of this genus. The species described here may be similar to *Hymonozonotriletes medius* Naumova, 1953, but an extension of the rays in the bladder beyond the spore body was not noted.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Grandispora? sp. A
Plate 3, figure 18

Description: Spores radial, trilete; central body enclosed by bladder, both subcircular in proximal view; trilete may be obscured by folds in bladder, rays extend to body margin; central body fairly thick, margin well defined; bladder thin, folded over body, extending 21–31 microns beyond body margin, with limbus 3–4 microns wide at equator; body exine probably levigate; bladder with small cones, not exceeding 3 microns in length and more frequent on portion overlying body, where they are 2–3 microns apart; bladder surface finely infragranulose (peppery); diameter 113–125 microns, body 54–60 microns (on two specimens only).

Hypotype: M 101, Slide 4, at 32.3 by 110.2 Dialux.

Remarks: This species is provisionally included in *Grandispora*; small cones instead of prominent spines are present, but otherwise the same features are represented.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

Genus PITYOSPORITES (Seward, 1914)
Potonié and Klaus, 1954

Pityosporites sp. A
Plate 3, figure 19

Description: Bisaccate pollen grain, without trilete mark; appearing bilateral due to presence of two bladders; elliptical in transverse plane, kidney-shaped in axial (longitudinal) plane; bladders placed subequatorially and converging distally; body oval in transverse plane, pear-shaped in axial plane; sulcus 12 microns wide; bladders 26–31 microns in longest diameter, approximately 29 microns wide; body 39 microns from pole to pole and 51 microns at equator; bladders infrareticulate, body very finely infragranulose (peppery); equatorial diameter of entire grain 72 microns.

Hypotype: M 101, Slide 1, at 48 by 96 Dialux.

Remarks: The genus *Pityosporites* is known from considerably younger strata, namely, from the Permian.

PLATE 1
All figures × 500, except as otherwise indicated.

1 *Leiotriletes notatus* sp. nov.
Holotype, 40 × 41.5 microns.
M 101, Slide 1 at 45.8 by 95.9 Dialux.

2 *Leiotriletes notatus* sp. nov.
Paratype, 47 × 53.6 microns.
M 101, Slide 9 at 27 by 110.4 Dialux.

3 *Leiotriletes* sp. *A*
43 × 47 microns.
M 101, Slide 10 at 26.8 by 98 Dialux.

4 *Leiotriletes* sp. *A*
47 × 47 microns.
M 101, Slide 6 at 32.5 by 94.4 Dialux.

5 *Punctatisporites debilis* sp. nov.
Holotype, 47 × 49 microns.
M 101, Slide 1 at 34.2 by 115 Dialux.

6 *Punctatisporites debilis* sp. nov.
Paratype, 35 × 45 microns.
M 101, Slide 10 at 30.4 by 100.8 Dialux.

7 *Punctatisporites irrasus* sp. nov.
Holotype, 68 × 74 microns.
M 101, Slide 4 at 32.3 by 96 Dialux.

8 *Punctatisporites irrasus* sp. nov.
Paratype, 64 × 80 microns.
M 101, Slide 1 at 48.3 by 109.4 Dialux.

9 *Punctatisporites? limbatus* sp. nov.
Holotype, 95 × 113 microns, × 250.
M 101, Slide 9 at 26.8 by 94.8 Dialux.

10 *Punctatisporites? limbatus* sp. nov.
Paratype, 155 × 183 microns, × 250.
M 101, Slide 7 at 20.6 by 99.5 Dialux.

11 *Punctatisporites? limbatus* sp. nov.
Paratype, 113 × 136 microns, × 250.
M 101, Slide 5 at 28.2 by 94.7 Dialux.

12 *Punctatisporites planus* sp. nov.
Holotype, 59 × 62 microns.
M 101, Slide 4 at 31.2 by 96.3 Dialux.

13 *Punctatisporites solidus* sp. nov.
Holotype, 51.5 × 55.6 microns.
M 101, Slide 5 at 46 by 110.9 Dialux.

14 *Punctatisporites viriosus* sp. nov.
Holotype, 68 × 72 microns.
M 101, Slide 1 at 48.4 by 112.9 Dialux.

15 *Cyclogranisporites naevulus* sp. nov.
Holotype, 68 × 72 microns.
M 101, Slide 10 at 39.7 by 111 Dialux.

16 *Cyclogranisporites* sp. cf. *C. pressoides* Potonié and Kremp, 1955
29 × 33 microns.
M 101, Slide 1 at 45.2 by 111.2 Dialux.

17 *Cyclogranisporites* sp. *A*
146 × 152 microns, × 250.
M 101, Slide 4 at 29.2 by 101.9 Dialux.

18 *Lophotriletes* sp. *A*
33 × 35 microns.
M 101, Slide 1 at 28.6 by 104.9 Dialux.

19 *Acanthotriletes* sp. *A*
33 × 39 microns.
M 101, Slide 1 at 46.4 by 102 Dialux.

20 *Acanthotriletes horridus* sp. nov.
Holotype, 161 microns (one segment folded over), × 250.
M 101, Slide 1 at 40.3 by 113 Dialux.

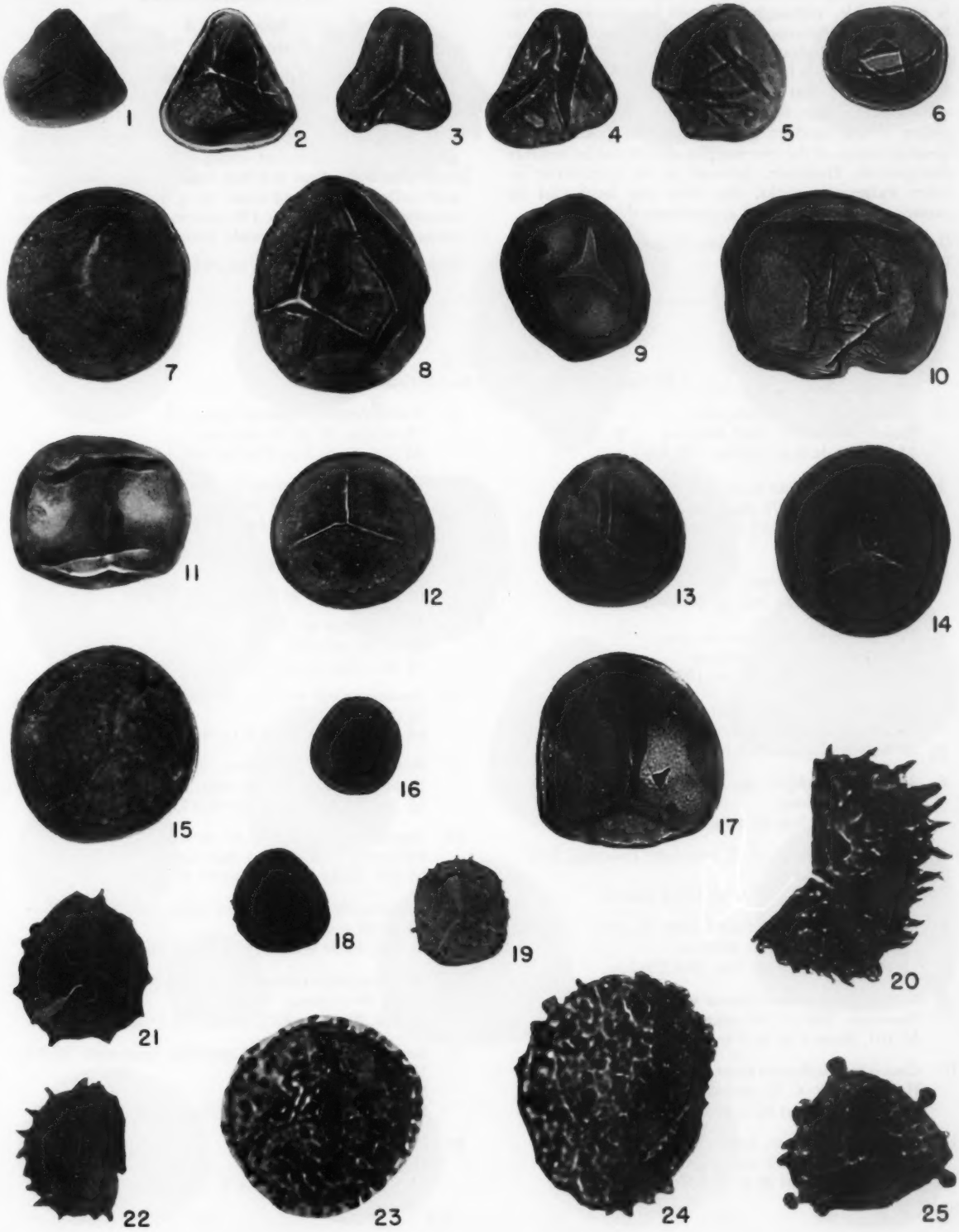
21 *Raistrickia ampullacea* sp. nov.
Holotype, 50 × 53.6 microns.
M 101, Slide 1 at 37.7 by 95.3 Dialux.

22 *Raistrickia ampullacea* sp. nov.
Paratype, 35 × 47.4 microns.
M 101, Slide 10 at 30.6 by 101 Dialux.

23 *Raistrickia baculosa* sp. nov.
Holotype, 74 × 76 microns.
M 101, Slide 6 at 38.5 by 105 Dialux.

24 *Raistrickia baculosa* sp. nov.
Paratype, 76 × 91 microns.
M 101, Slide 4 at 28.5 by 112.6 Dialux.

25 *Raistrickia clavata* sp. nov.
Holotype, 58 × 62 microns.
M 101, Slide 7 at 31.4 by 113.4 Dialux.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Its presence in lowermost Lower Carboniferous strata is remarkable, although it should be mentioned that Radforth and McGregor (1954) report its occurrence in Upper Devonian strata in Alberta, and Williams (1955) mentions the genus from Westphalian A, B and lower C equivalents in Great Britain. Since it is difficult to separate this type from Recent abietineous genera, such as pollen of the modern genus *Pinus*, the possibility of contamination of the two samples should not be entirely disregarded. However, because of its occurrence in other Palaeozoic rocks, the view was held that its presence must be reported as pertinent evidence.

Occurrence: Horton group, Nova Scotia, West Gore and Blue Beach samples.

GENUS INDETERMINATE

Spore type A

Plate 3, figure 20

Description: Spore radial, trilete; subcircular in outline; trilete obscure, rays probably extend to body margin; body fairly dense, margin not distinct, conformable with equatorial outline; on body surface, probably rounded projections; at margin, irregular plate-like scalloped units that overlap onto flange; flange thin and ruffled, with lobed outer margin that is very finely dentate; diameter 103 × 130 microns, body 58 × 76 microns, flange 27 microns wide (one specimen only).

Hypotype: M 101, Slide 10, at 24.6 by 93.6 Dialux.

PLATE 2

All figures × 500, except as otherwise indicated.

1 *Raistrickia? gibberosa* sp. nov.
Holotype, 76.2 × 76.2 microns.
M 101, Slide 6 at 27.8 by 100 Dialux.

2 *Raistrickia pistillata* sp. nov.
Holotype, 67 × 76 microns.
M 101, Slide 5 at 43.7 by 96 Dialux.

3 *Raistrickia* sp. *A*
47.4 × 53.6 microns.
M 101, Slide 7 at 26.6 by 112.8 Dialux.

4 *Verrucosisporites papulosus* sp. nov.
Holotype, 43 × 53 microns.
M 101, Slide 1 at 47.2 by 108.4 Dialux.

5 *Verrucosisporites papulosus* sp. nov.
Paratype, 59 × 60 microns.
M 101, Slide 6 at 26.8 by 93.4 Dialux.

6 *Microreticulatisporites* sp. *A*
50 × 58 microns.
M 101, Slide 5 at 46.4 by 108.3 Dialux.

7 *Reticulatisporites* sp. cf. *R. reticulatus* Ibrahim, 1932
68 × 92 microns.
M 101, Slide 2 at 28.4 by 104.4 Dialux.

8 *Convolutispora flexuosa* forma *major* sp. nov.
Holotype, 181 × 185 microns.
M 101, Slide 2 at 27.7 by 99.6 Dialux.

9 *Convolutispora flexuosa* forma *major* sp. nov.
Paratype, 206 × 206 microns, × 250.
M 101, Slide 1 at 36.7 by 111.5 Dialux.

10 *Convolutispora flexuosa* forma *minor* sp. nov.
Holotype, 55 × 72 microns.
M 101, Slide 9 at 32.5 by 94.9 Dialux.

11 *Lycospora torulosa* sp. nov.
Holotype, 43 × 53 microns.
M 101, Slide 2 at 27.6 by 104.3 Dialux.

12 *Vallatisporites vallatus* sp. nov.
Holotype, 57 × 61 microns.
M 101, Slide 5 at 39.6 by 106.3 Dialux.

13 *Vallatisporites verrucosus* sp. nov.
Holotype, 51 × 57 microns.
M 101, Slide 1 at 44.6 by 112.1 Dialux.

14 *Vallatisporites* sp. *A*
68 × 68 microns.
M 101, Slide 4 at 29 by 113.7 Dialux.

15 *Vallatisporites* sp. *B*
80 × 84 microns.
M 101, Slide 6 at 35 by 113.1 Dialux.

16 *Stenozonotriletes* sp. cf. *S. conspersus* Naumova, 1953
35 × 37 microns.
M 101, Slide 5 at 31.6 by 94.4 Dialux.

17 *Stenozonotriletes deltoides* sp. nov.
Holotype, 72 × 74 microns.
M 101, Slide 2 at 31 by 98.9 Dialux.

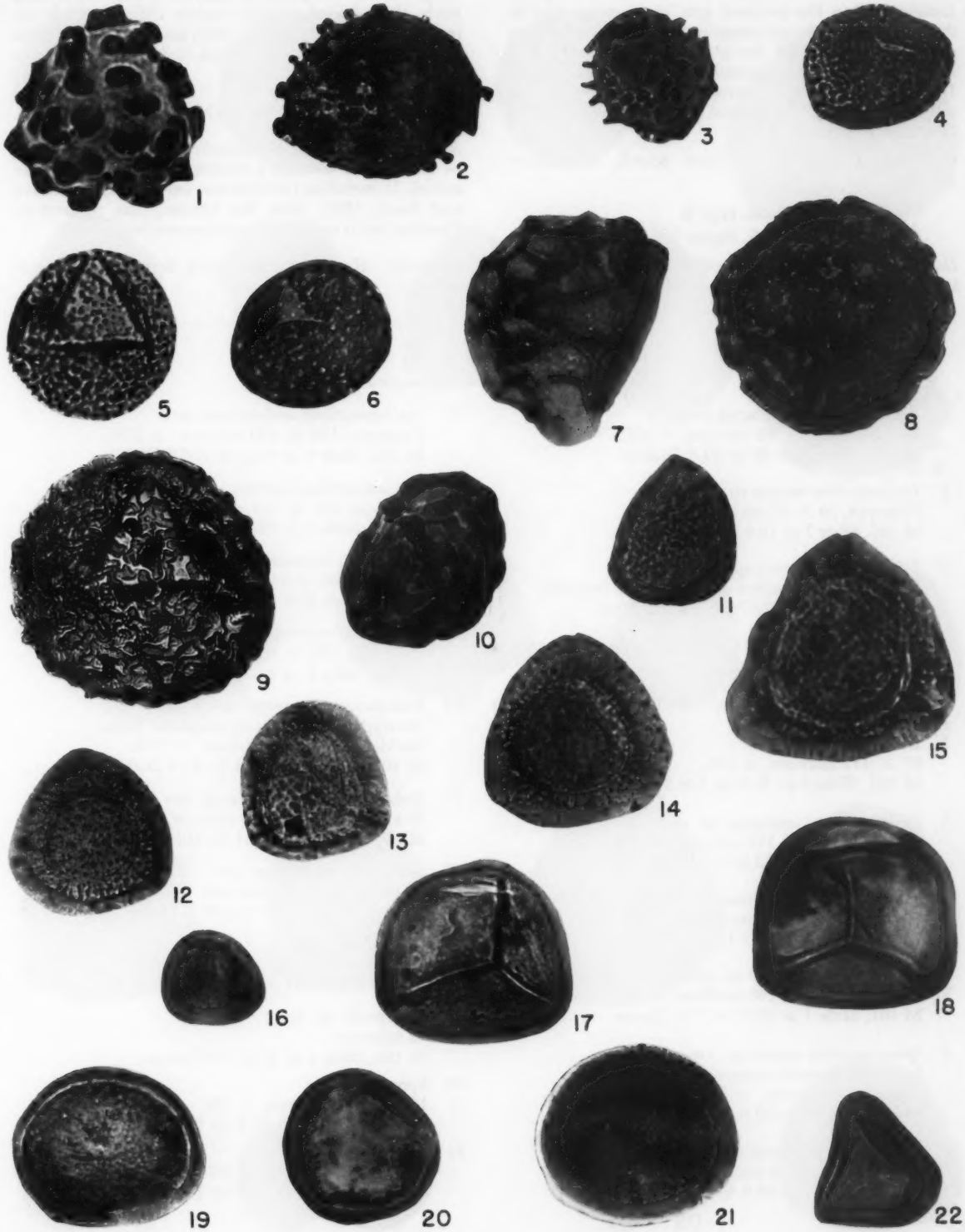
18 *Stenozonotriletes deltoides* sp. nov.
Paratype, 82.5 × 86.5 microns.
M 101, Slide 1 at 45.8 by 91.8 Dialux.

19 *Stenozonotriletes extensus* var. *major* Naumova, 1953
58 × 68 microns.
M 101, Slide 4 at 33.7 by 106.9 Dialux.

20 *Stenozonotriletes extensus* var. *major* Naumova, 1953
54 × 56 microns.
M 101, Slide 10 at 27.9 by 93.2 Dialux.

21 *Stenozonotriletes?* sp. cf. *Zonotriletes stenozonalis* Waltz, 1938
64 × 74 microns.
M 101, Slide 6 at 34.9 by 113.2 Dialux.

22 *Stenozonotriletes* sp. *A*
47 × 53 microns.
M 101, Slide 10 at 30.8 by 93.2 Dialux.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Remarks: In construction, this spore resembles the genus *Lepidozonotriletes* Hacquebard, gen. nov., except that in this form a true flange seems to be represented. More specimens are needed for a generic assignment. The species resembles *Hymonozonotriletes polystichus* Naumova, 1953, from the Upper Devonian of the U.S.S.R., as well as Species I C of Thomson (1940), from the Middle Devonian of Estonia.

Occurrence: Horton group, Nova Scotia, West Gore sample.

Spore type B
Plate 3, figure 21

Description: Spores radial, trilete; convexly subtriangular in proximal view; trilete distinct, rays with broad flanges (folds) to equator or apparently so; central body fairly thin, folded, margin poorly defined, finely infragranulose; flange narrow, thin, smooth, 6–10 microns wide; diameter 130–175 microns, body 115–154 microns (on five specimens).

Hypotype: M 101, Slide 10, at 43.5 by 103.6 Dialux.

Remarks: This spore is not classified because it could not be determined whether a bladder or a flange is represented. It resembles *Cirratriradites latitriletes* Hacquebard and Barss, 1957, from the Mississippian of western Canada, but is at least 63 microns smaller.

Occurrence: Horton group, Nova Scotia, West Gore sample.

PLATE 3
All figures × 500, except as otherwise indicated.

1 *Leiozonotriletes insignitus* sp. nov.
Holotype, 98 × 103 microns, × 250.
M 101, Slide 5 at 42 by 97.8 Dialux.

2 *Leiozonotriletes meracus* sp. nov.
Holotype, 58 × 67 microns.
M 101, Slide 7 at 19.8 by 102.1 Dialux.

3 *Leiozonotriletes meracus* sp. nov.
Paratype (body pulled out), 48 × 56 microns.
M 101, Slide 9 at 22.7 by 101.2 Dialux.

4 *Leiozonotriletes* sp. cf. *Archaeozonotriletes primarius* Naumova, 1953, comb. nov.
86.5 × 86.5 microns.
M 101, Slide 1 at 46.3 by 112 Dialux.

5 *Leiozonotriletes* sp. *A*
97 × 117 microns, × 250.
M 101, Slide 5 at 32.8 by 109.8 Dialux.

6 *Spinozonotriletes tenuispinus* sp. nov.
Holotype, 103 × 113 microns, × 250.
M 101, Slide 7 at 33.3 by 94.3 Dialux.

7 *Spinozonotriletes tenuispinus* sp. nov.
Paratype, 88 × 113 microns, × 250.
M 101, Slide 2 at 20.7 by 111 Dialux.

8 *Spinozonotriletes uncatus* sp. nov.
Holotype, 144 × 148 microns, × 250.
M 101, Slide 1 at 40.8 by 97.5 Dialux.

9 *Spinozonotriletes uncatus* sp. nov.
Paratype, laterally compressed specimen, 124 × 124 microns, × 250.
M 101, Slide 3 at 30 by 93.7 Dialux.

10 *Spinozonotriletes uncatus* sp. nov.
Paratype, 93 × 93 microns.
M 101, Slide 4 at 28.2 by 96.7 Dialux.

11 *Lepidozonotriletes aculeatus* sp. nov.
Holotype, 134 × 150 microns, × 250.
M 101, Slide 4 at 45.2 by 110.6 Dialux.

12 *Lepidozonotriletes aculeatus* sp. nov.
Paratype, 104 × 113 microns, × 250.
M 101, Slide 2 at 28.7 by 110.4 Dialux.

13 *Endosporites angustus* sp. nov.
Holotype, 95 × 110 microns, × 250.
M 101, Slide 9 at 25.5 by 98.3 Dialux.

14 *Endosporites macromanifestus* sp. nov.
Holotype, 140 × 150 microns, × 250.
M 101, Slide 2 at 24.3 by 99.1 Dialux.

15 *Endosporites macromanifestus* sp. nov.
Paratype, showing body displaced below bladder, 124 × 144 microns, × 250.
M 101, Slide 10 at 24.4 by 93.6 Dialux.

16 *Endosporites micromanifestus* sp. nov.
Holotype, 76.2 × 88.6 microns.
M 101, Slide 10 at 36.1 by 101.6 Dialux.

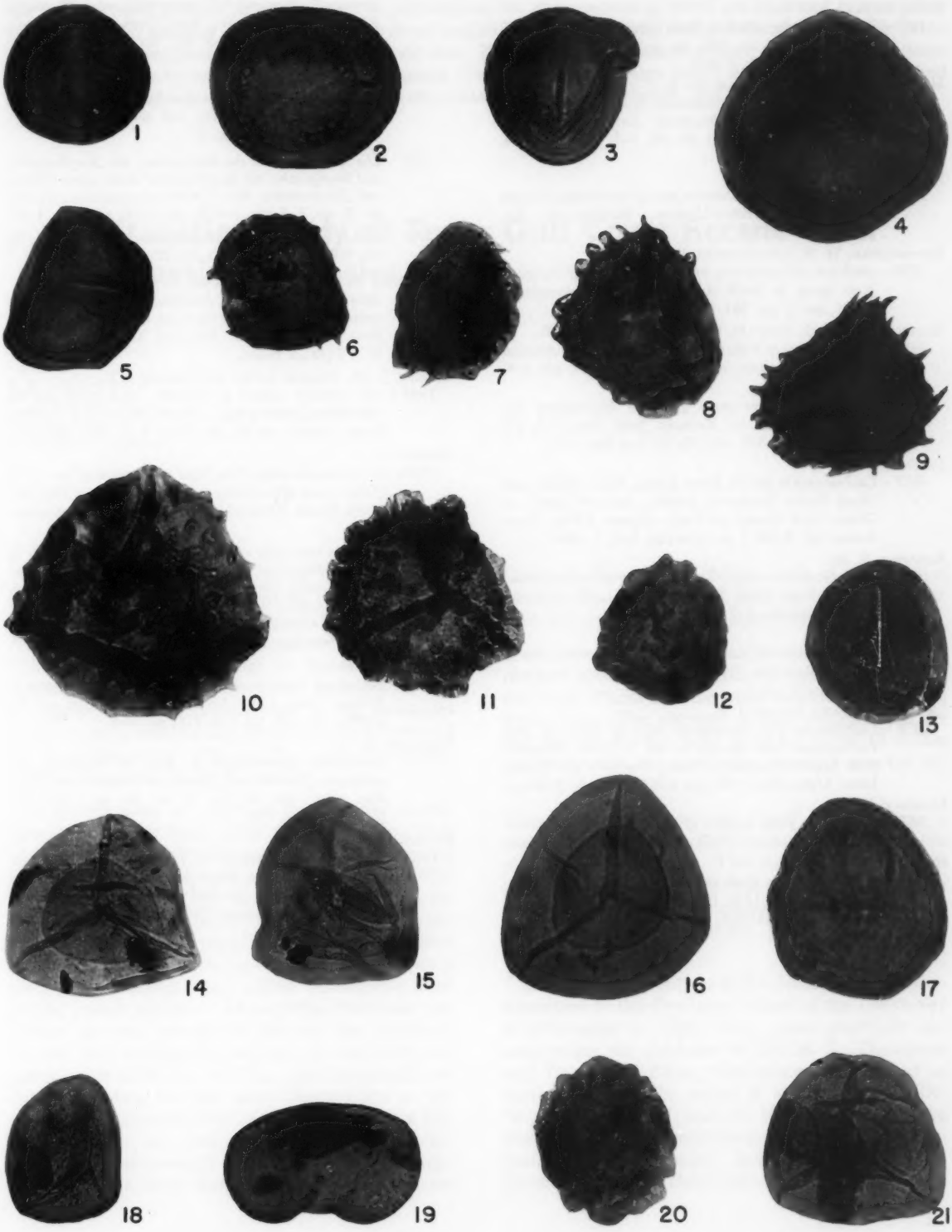
17 *Grandispora echinata* sp. nov.
Holotype, 64 × 72 microns.
M 101, Slide 2 at 21 by 103.9 Dialux.

18 *Grandispora?* sp. *A*
87 × 113 microns, × 250.
M 101, Slide 4 at 32.3 by 110.2 Dialux.

19 *Pityosporites* sp. *A*
72 microns.
M 101, Slide 1 at 48 by 96 Dialux.

20 Spore type A
103 × 130 microns, × 250.
M 101, Slide 10 at 24.6 by 93.6 Dialux.

21 Spore type B
144 × 161 microns, × 250.
M 101, Slide 10 at 43.5 by 103.6 Dialux.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ABSTRACT: *One hundred fifty-eight approximately equal-volume samples of Recent sediments from Matagorda Bay, Texas, and adjacent areas yielded sixty-nine species of foraminifera, the more common of which are illustrated by stereophotomicrographs. The utility of statistical methods in faunal analysis is shown. Statistical studies indicate that probably twelve significantly different foraminiferal facies exist in the area. There is general agreement between the foraminiferal facies pattern and the physiographic and oceanographic features. The more important ecologic factors determining the foraminiferal distribution are probably salinity, organic content of the sediments, intensity of turbulence, and biologic competition.*

Statistical study of Texas Gulf Coast Recent foraminiferal facies

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INTRODUCTION

This study of the distribution of foraminifera in Recent sediments from Matagorda Bay, Texas, and adjacent environments was undertaken in order to develop methods for the recognition and interpretation of foraminiferal facies by quantitative and qualitative means. It is hoped that the methods can be applied to the reconstruction of the lithotopes and biotopes of fossil foraminiferal faunas encountered in the sedimentary rocks of the geologic column, particularly those of the Cenozoic.

The sample area is a part of the offshore island-fringed northwest coast of the Gulf of Mexico. It is bounded by lat. 28°30′ N. and lat. 28°46′ N. on the north and south, respectively; and by long. 95°36′ W. and long. 96°14′ W. on the east and west, respectively. The area includes the following physiographic and oceanographic features: the shallow littoral zone just below low-tide line; the beach sand of the offshore bar called Matagorda Peninsula; marsh ponds of Matagorda Peninsula just behind the sand portion of the bar; the relatively shallow East Matagorda Bay and its tidal inlet; the eastern arm of Matagorda Bay; the Colorado River delta separating the two bays; Oyster Lake on the mainland (separated from Matagorda Bay by a low swampy zone but connected to the bay by the intercoastal waterway); marsh ponds of the mainland near the land margins of the bays; and the Colorado River channel just north of the town of Matagorda. In a general physiographic sense, the area is a typical low-lying emergent coastal plain.

The climate of the area is that of the humid subtropical zone, grading into the steppe climate of the Great Plains and the more westerly parts of the Gulf Coast. The average annual precipitation for the Matagorda Bay area is about 40 to 42 inches per year, with the maximum monthly average occurring in September.

The main stream carrying runoff into the bays is the Colorado River, which has its headwaters in the plains of New Mexico. This stream flows through areas subject to periodic heavy rainfalls and with sparse vegetation, and consequently the Colorado River is commonly heavily laden with silt and mud.

This report represents part of a doctoral dissertation submitted to the Graduate School of the University of Wisconsin in 1955. The writer gratefully acknowledges the guidance of Dr. M. L. Thompson and Dr. L. M. Cline, who successively served as thesis advisors. The writer is also grateful to Dr. Noyes D. Smith, Jr., and Dr. H. A. Bernard, of the staff of the Shell Development Company, for suggesting the area of study. Acknowledgment is also given to the Shell Development Company for col-

lecting the samples and the basic data on the locations, etc. Appreciation is extended to Wesleyan University for providing financial assistance, equipment, laboratory space, and secretarial services.

PREVIOUS WORK

Within the past decade, increasing research efforts have been devoted to the investigation of the general oceanography of the shore areas of the Gulf of Mexico, its existing sedimentary environments and their distribution and controlling factors, its biologic complex, and the relationships of these. Earlier studies of the foraminifera of the Gulf of Mexico (Cushman, 1918–1931; Kornfeld, 1931; and Bermudez, 1935) were principally concerned with the taxonomy of the foraminifera, minor attention being given to distribution, ecologic factors, relations to sedimentary environments, and similar subjects. Of the more recent studies referred to above, Project 51 of the American Petroleum Institute has the broadest scope. Particular phases of this investigation have been reported upon by various authors over an interval of several years. Of greatest pertinence to the present report are the following: The study of the ecology of the foraminifera of the northwestern Gulf of Mexico by Phleger and Parker (1951); the report on the ecology of the foraminifera of San Antonio Bay by Parker, Phleger, and Peirson (1953); a paper on the ecology of the foraminifera of the southeastern Mississippi Delta area by Phleger (1955); a study of living foraminiferal populations of the central Texas coast by Phleger (1956); an oceanographic study of the Mississippi Delta sedimentary environments by Scruton (1956); and a sedimentation study of the Mississippi Delta margins by Shepard (1956). Other recent studies of the foraminiferal faunas of the Gulf of Mexico and their ecology are those of Bandy (1954, 1956) and of Lowman (1949), the latter being concerned primarily with the broad sedimentary facies pattern of the Gulf Coast.

METHODS OF STUDY

During the spring of 1953, 158 samples of bottom sediments were collected within the area described. The locations of the samples and their number designations are given in text-figure 1. The location of each sample to the nearest second of longitude and latitude is on file at the Shell Development Company Laboratories in Houston, Texas, as well as in the writer's files.

The samples were collected with a core barrel or a heavy-duty grab sampler. The grab sampler was used in areas of sandy bottom or in cases where the depth of water prohibited the use of the core barrel, which was run on a long pole. The core barrel was of the ball-valve type, with a plastic inner liner having an inside diameter of approximately two inches.

One-half of the upper few centimeters of the undisturbed core, or a small fraction of the grab sample, depending on the tool used to collect the sample, was placed in a glass bottle for this study. The total volumes of the original samples were nearly uniform, but the total dry weights varied between 40 and 70 grams, with the great majority weighing between 50 and 60 grams. These variations in the weight of the samples may have been to a slight extent due to unequal sizes (volumes) of the portions of the original samples, but the greater cause of variation in weight was undoubtedly variation in the amount of water retained by the different types of sediment. This "pore" water, of course, was driven off during the drying process.

Before any of the samples were treated, particular samples were selected for size analysis and population counts of the foraminifera. These samples are designated in Tables 1 through 4, in which the basic size-distribution and foraminiferal population data are recorded.

After several of the samples had been examined for foraminifera, it became apparent that nearly all specifically identifiable specimens were in the 1.98 to 0.24 mm. size-range fractions of the Tyler screen series. In addition, it was evident that much time and effort could be saved by concentrating the foraminifera in some manner. Bandy (1954, p. 126) and some previous workers had reported successful separation of Recent foraminifera by flotation in a carbon tetrachloride medium, and this technique was used for all the samples studied. Successive small portions (about 5 grams) of the size fraction to be separated were poured onto a medium-sized watch glass, and the carbon tetrachloride added. By gentle "panning," the foraminifera were floated and decanted off onto filter paper in a glass funnel; the residue was then poured and rinsed onto another filter paper. Because of the high rate of evaporation of carbon tetrachloride (hence quick drying of the sample), this is a rapid and easy technique for separating foraminifera. Binocular examination of the residue indicated that very few foraminifera were not separated in this manner.

The stereophotomicrographs illustrating the more abundant species found in the sample area were taken with an Exakta camera adapted to an American Optical petrographic microscope. Fournier's

(1956) technique of dark-field illumination and translation of specimen from one end of the photographic field to the other to obtain the stereopairs was employed with some modifications. What would appear to be a simpler mounting technique was used. In place of the "Stay Flat" solution on a glass slide recommended by Fournier, the writer found that a thin film of gum tragacanth on a glass slide worked very satisfactorily. It allowed easy orientation of specimens as well as good light transmission. There is some tendency for the irregular surface of the dried gum tragacanth to reflect spots of light in the area surrounding the specimen. However, by polarizing the light sources (cutting celluloid polaroid filters for the lamps) and inserting the analyzer in the optical system, the great majority of these reflection spots in the background were cut out. For any particular focus of the lamps, the analyzer is easily rotated to that position which reduces to a minimum the light spots in the background. The objective used was a Wollensak 20 mm. *f*.3.5 to *f*.16 Anastigmat with either a 9× or 15× ocular in the microscope tube. This resulted in enlargements of about 15.5× and 32×, respectively, on the film, which was Kodak Panatomic X. In the case of some of the larger specimens, the entire 35 mm. frame was filled, so that a larger magnification on 35 mm. film was not obtainable.

Ninety-eight samples, including those samples which were analyzed for grain-size distribution, were selected for counts of the total foraminiferal population of the samples, as well as of the total number of individuals of each species and variety present. These samples were selected from all geographic areas, and are indicated in Tables 1–4. For the population-count work, a shallow, black-backed specimen-picking tray was ruled with white ink to produce a one-centimeter grid. The foraminiferal concentrate of a sample was poured on the tray and distributed over the surface so that the material was only one grain deep. In cases in which the total population was very large, the grid facilitated counting determinable fractions of the total population. The total population data entered in Tables 1 through 4 are actual counts of all the specimens in a sample, unless the figure given in the table is underlined, in which case it is a derived figure based on the count of a particular fraction of the sample with a minimum population of 400 specimens.

On the basis of the total number of specimens actually counted in a sample, the relative percentage of the sample's total population represented by each species or variety was computed and recorded. In Tables 1 through 4, these percentage figures have been rounded off to the nearest one-tenth of one per cent.

To facilitate as objective an interpretation of the data as possible, comparison of means tests for significant differences were performed. The mean percentage of each of the five most common species in each of the twelve areas listed in Table 5 was compared with the mean percentages of that species in every other area. Because of variation in the number of samples (four to nineteen for population data) used in deriving the mean for a particular area, the Student "t" test was deemed most applicable. What is really being determined by this test is the degree of probability that the two sample means being tested differ from each other no more than might be expected by random sampling of a normally distributed population. In terms of the immediate problem, this null hypothesis (or hypothesis of no difference) might be stated as follows: The means (frequency of species of foraminifera) of samples from the two areas being compared differ no more than might be obtained by random sampling of a normally distributed population.

The probability-value level at which the null hypothesis is to be rejected is governed by several considerations, which are generally discussed in texts on statistical methods. Conventional use of probabilities usually involves rejection of the null hypothesis when the probability value is 0.05 or less. This means that in one situation out of twenty, the null hypothesis, although correct, is rejected, or conversely, that 95 per cent of the time one can be confident that the rejection of the null hypothesis is correct. In this study, the 0.05 probability-value level (95 per cent confidence level) was accepted as indicating a significant difference.

The following equation was used for determining "t" in the significant difference of means test:

$$\text{"t"} = \frac{\overline{X}_a - \overline{X}_b}{\sqrt{\frac{(N_a - N_b)\,(\Sigma X_a^2 + \Sigma X_b^2 - N_a\overline{X}_a^2 - N_b\overline{X}_b^2)}{N_a N_b\,(N_a + N_b - 2)}}}$$

N_a = number of samples from one area
N_b = number of samples from other area
X_a = observed value for a sample from area a
X_b = observed value for a sample from area b
Σ = summation
$\overline{X}_a$ = mean for area a
$\overline{X}_b$ = mean for area b

With this "t" value and the appropriate number of degrees of freedom (two less than the total number of samples of the two areas concerned), the appropriate probability value was determined from a graphic plot of "t" against probability for different degrees of freedom.

It must be emphasized that, even if the difference between two sample-area means is significant, statistical methods can tell nothing about the cause of the deviation. It may be that the two areas sampled are really different, or that there was some difference in sampling technique from one area to the next, so that the samples are not true random samples. Inasmuch as every precaution was taken to insure unbiased sampling and treatment of data, the latter alternative for the interpretation of significant difference of means has been generally rejected in this study. Similarly, significant-difference tests cannot provide criteria for choosing between hypotheses that might be compatible with the data. This decision must be made on non-statistical grounds.

The basic data on the foraminiferal populations and grain-size distribution of the bottom sediments are presented in the conventional form of tables. Tables 1 through 4 contain data on the lower taxa of the foraminifera found, the relative percentage of each taxon in each sample, total population figures (actual count, or estimate if figure is underlined), depth of water, median grain-size, and sorting coefficient for each sample for which these data have been determined. In the tables, the samples are grouped according to the geographic area from which they were obtained. The occurrence of foraminiferal species in samples on which no population counts were made is marked by dashes in the appropriate row.

Table 5 presents the basic data and results of the Student "t" tests of the difference of means for the five most common species from the twelve major geographic areas. The species so studied were *Elphidium galvestonense*, *Elphidium gunteri*, *Palmerinella palmerae*, *Streblus pauciloculatus*, and *Streblus beccarii* and variants. To demonstrate how the probability values have been entered on the table, the following illustration is presented. Assume that it is desirable to know the probability that the null hypothesis is correct for each of the five species from Matagorda "fore" bay as compared with Matagorda "back" bay. The square that marks the intersection of the horizontal row labeled "Matagorda 'fore' bay" with the column captioned "Matagorda 'back' bay" contains the probability values for two species (identified by the legend). The remaining probability values for the other three species are in the square that marks the intersection of the row labeled "Matagorda 'back' bay" with the column captioned "Matagorda 'fore' bay." The five probability values for any two areas compared always lie along a diagonal that slopes upward to the right.

Several types of figures are presented to facilitate understanding of various aspects of the data and to bring out certain aspects of the data that are not readily apparent in tabulated form. A generalized picture of the distributional pattern of the thirteen most abundant species of foraminifera in the area is given in text-figures 2 through 4. In text-figures 2 and 3, the mean relative percentage of each of the thirteen species in the fourteen natural geographic areas identified in Tables 1 through 4 are compiled as a histogram. The changes in the mean relative frequency of an important species from one geographic area to another are thus quite apparent. Text-figure 4 presents the data given in text-figures 2 and 3 in the form of cumulative frequencies, in order to illustrate the composition of the foraminiferal fauna of a geographic area in terms of the most abundant species and to portray the changes in the composition of the foraminiferal fauna from one area to another.

ECOLOGIC FACTORS

Depth of water

The water of the bays is comparatively shallow, with the maximum depths near the centers. The maximum depth below mean low water from which samples were collected in Matagorda Bay was 15 feet, with the majority of samples from depths of less than 5 feet. In East Matagorda Bay, the maximum depth from which samples were collected was 6½ feet near the center of the bay, with the majority coming from depths of 5 feet or less. The peninsula and mainland marsh ponds sampled are small bodies of water, and the maximum depth from which samples were obtained was 4 feet. Oyster Lake samples were collected from a maximum depth of 2 feet. The average depths of water for the "fore" (peninsular margin) and "back" (land margin and main part) bays differ very little, and are probably insignificant in determining the ecology of the bay foraminifera. Similarly, the depths of water from which the samples were collected around the Colorado River delta, in Oyster Lake, in mainland marsh ponds and in those of the peninsula, as well as in those of the delta itself, are quite similar. The significant differences that exist in the foraminiferal faunas of these areas are quite probably not primarily controlled by water depth. The distribution of

the foraminifera in an area with respect to the depth of the water indicates that the depth ranges of the species occupying the area exceed the variations in water depth that are found within the area. This would appear to be consistent with results of bathymetric zonations of foraminifera reported in other studies in the Gulf of Mexico. Bathymetric zones of foraminifera in the deeper waters of the Gulf of Mexico, as well as in bodies of water elsewhere in the world, have been defined and described in recent investigations of benthonic foraminifera in bottom sediments. Most authors attribute the bathymetric zonation they describe to controlling factors other than depth of water itself. Bandy (1954, p. 135) presents a possible exception when he states: "Many faunal trends could not be correlated with the physical conditions other than change in depth. Perhaps such trends will be found to correlate with turbidity conditions, light penetration, or characteristics of bottom plants."

Circulation

The mixing of the waters within the bays with that of the Gulf of Mexico is controlled by tidal inlets that have breached the offshore bar. Each of the bays has at least one tidal inlet that appears to remain open quite consistently. The inlet of East Matagorda Bay is nearly at the extreme eastern end of the bay. Tides flowing into the bay through this inlet have built a small tidal delta into the bay. Greens Bayou inlet, at the extreme western edge of the area sampled, provides one connection between Matagorda Bay and the water masses of the Gulf. The sill depth in both of these inlets is between 1 and 2 feet below mean low water. In addition, there is a still larger inlet, Cedar Bayou, to the southwest of the sample area, which provides for mixing of the water of the main portion of Matagorda Bay with water masses of the Gulf of Mexico.

Salinity

Salinity determinations of the waters of the bays and Gulf were not made at the time of sampling. Parker, Phleger, and Peirson (1953), in their study of the distribution of foraminifera in San Antonio Bay and environs, to the southwest of the area under study, reported salinities ranging from 2.9 parts per thousand, near the Guadalupe River effluent, to approximately 42 parts per thousand in San Antonio Bay proper, with Gulf water salinities of 36.2 to 36.4 parts per thousand. Their salinity determinations were made in mid-August of 1951, during the annual dry period of that area, when precipitation and consequent runoff are exceeded by the rate of evaporation. Because of several factors, the salinity of the water in Matagorda Bay and East Matagorda Bay at the time of sampling is thought to have been considerably lower than the salinities found by Phleger, Parker, and Peirson in San Antonio Bay in 1951. One factor is that the samples for this study were collected during May and June, when, according to the data presented by Hedgpeth (1951, text-fig. 5), the salinities of the bays of this region are 5 to 10 parts per thousand lower than they are in August. Secondly, the Matagorda Bay area lies to the northeast of the San Antonio Bay area and receives a slightly higher annual rainfall and consequently a greater surface runoff into the bays, which results in lower salinities. There is no reason to suspect that the salinity of the Gulf water of the littoral zone differs from that of the same zone in other areas of the northwestern part of the Gulf of Mexico. The salinity of the Gulf water in the littoral zone of the study area was therefore approximately 36 parts per thousand.

In view of the data presented above, the salinity of the water in the bays at the time of sampling probably ranged from about 2 to 3 parts per thousand, near the distributaries of the Colorado River, to about 20 parts per thousand in the bays proper. Oyster Lake, with its restricted connection with Matagorda Bay and lack of any important stream carrying surface runoff, probably had a water salinity about the same as that of the bays or slightly higher. The salinity of the mainland marsh ponds and the ponds on the delta probably ranged from less than 1 part per thousand to 5 or 10 parts per thousand. The marsh ponds of Matagorda Peninsula quite probably had salinities intermediate between those of the bays and the open Gulf, although wide geographical and temporal fluctuations probably occur because of seasonal rains and wash-over of Gulf water during periods of Gulf storms.

The distribution of the foraminifera described, and the undoubted variation in salinities within the area, strongly suggest that salinity of the water is a major factor in determining the ecology of the foraminifera of this area.

Temperature

Water-temperature data were not recorded at the time when the samples were collected. Temperatures of the waters of Galveston Bay, Aransas Bay, Copano Bay, and the Laguna Madre of the Gulf area are summarized and presented graphically by Hedgpeth (1951, p. 54, text-fig. 5). The data presented by Hedgpeth indicate that, unlike salinity,

the temperatures of the water masses in the various bays of the northwestern coast of the Gulf of Mexico undergo the same annual fluctuation in water temperatures. The annual reported range was from 13° C. to 31° C. The data reported by Hedgpeth are the mean monthly temperatures for the various bays, determined over a period of several years, so that it is quite likely that the annual water-temperature range given above is a conservative figure in terms of temperature extremes. Parker, Phleger, and Peirson (1953, p. 3) indicate that the actual extreme range of water temperatures in the bays may well be 5° to 10° C. in excess of that reported by Hedgpeth on the basis of a maximum surface temperature in San Antonio Bay of 34.7° C. in August of 1951.

The water-temperature ranges reported by Hedgpeth for the bays listed may well be taken as representative of those of Matagorda Bay and East Matagorda Bay. Although it is quite certain (because of the shallow depth) that the water temperature in the bays varies insignificantly with depth and with location within the bays, the above data give some measure of the temperature tolerances (not necessarily maximal and minimal) of the foraminifera that inhabit the bays. These considerations strongly suggest that water temperature is an unimportant factor in producing the distribution of foraminifera that exists in the area under study.

Bottom sediments

As is the case in most of the northwestern and western coastal areas of the Gulf of Mexico, the seaward side of the peninsula (offshore bar) is composed of medium-grained sand, and the bay margins of the peninsula are composed of fine-grained sand, silt, mud, and organic debris from the extensive swamps on that side of the offshore bar. The Colorado River delta and the mainland margins of the bay are dominated by extensive swamps, with the sediments being predominantly very fine-grained sand, silt, mud, and the organic debris of the swamps.

In terms of the grain-size of the sediments, three general areas are identifiable within the sample area. The sediments of the Gulf side of Matagorda Peninsula and of the Gulf littoral zone are composed of fine sand (mean median size for all samples studied: 0.160 mm.) with very good sorting (mean sorting coefficient of samples analyzed: 1.25). As indicated in Table 1, several of the samples from Matagorda Peninsula had median grain-sizes and sorting coefficients significantly different (greater) than the mean for the area. In all these cases, this deviation was due to the abundance of fragmented shell material in the bottom sediments represented by the particular sample. The sediments of the "fore" bays are composed of very fine sand, with very good sorting coefficients. The mean median grain-size for samples analyzed from this area is 0.0849 mm., with a sorting coefficient of about 1.15. The sediments of the "back" bays are composed of silt (mean median grain-size of 0.0337 mm.), with a sorting coefficient of about 1.15. Although no reliable size analyses of the samples from the centers of the bays were obtained, it is probable that the bottom sediment is composed of material in the clay size-range.

Although there undoubtedly exists a correlation between the average grain-size of the bottom sediment of the sample area and the distribution of the foraminiferal faunas (indeed, a lithofacies map and a biofacies map of the area would be very similar in pattern), it seems very probable that this is not a true causal relationship (i.e., grain-size being a determining factor in foraminiferal distribution). It is more likely that other ecologic factors are the common denominators in producing this correlation. Quite probably, the dominant factor in this case is the nature of the current action and the turbulence of the overlying water-mass. Hydrodynamic factors of the sedimentary process indicate that (other factors being the same) areas of comparatively turbulent water will have coarser bottom sediments than areas of comparatively quiescent water. At the same time, some foraminifera will not be able to inhabit the more rigorous environment of turbulent water and strong current action, whereas under the same conditions but with quiet water, they will flourish. It is also entirely possible that some of the foraminifera that inhabit the more turbulent waters may not be proportionately represented in the sediments that accumulate in the area because, after death, some may be selectively removed from the sediment by abrasive action or by selective transportation by the turbulent water.

Organic material

Although no determinations were made of the quantity of organic material in the samples, samples that were obviously high in organic content or that contained little or no organic material were noted. Generally, the samples with the lowest organic content were those from the littoral zone and from the beach on Matagorda Peninsula. As a group, the marsh-pond samples from the mainland, from the delta, and from Matagorda Peninsula generally had the highest organic content of the samples from the area. The amount of organic material in the sediments of the bays was perhaps the most variable of

all, but was generally intermediate between those of the littoral-beach zone and those of the marsh ponds. Since no quantitative data are available on the variations of the organic content of the sediments within the area studied, it is impossible to make generalizations concerning the distribution of foraminifera in relation to the organic content of the bottom sediment. The general variations in organic content from one area to the other, described above, correlate in general with variations in population density. The average total population per sample was highest for those areas containing the most organic material (for average total-population figures for each area, see the following discussion on ecology and distribution of foraminifera). Said (1950, p. 28), in his study of the foraminifera of the Red Sea, and Phleger and Walton (1950, p. 293), in their study of Barnstable Harbor, indicate that organic content of the bottom sediments was probably a major factor in producing variations in population density and in distribution of the foraminifera in those areas. The organic content of the sediments of any area is the result of a complex of ecologic factors, such as extent of organic activity (which is itself controlled by a complex of factors), depth of water, kinds and density of scavengers, oxidation rate, turbulence, etc. Organic content of bottom sediments commonly increases as the grain-size of the sediment decreases, due to common controlling factors.

Other ecologic factors

The remainder of the benthonic fauna, as well as the nektonic fauna and the flora of the area, is probably a significant factor in the ecology of the foraminifera, but these factors are very difficult, if not impossible, of assessment. The foraminifera are certainly in competition with other benthos for the available food supply, and also constitute food for some other benthos and for some nekton. The amount of light penetration, the oxygen content, and similar factors that affect the ecology of organisms in deeper waters are quite constant in the very shallow waters of the area under study, and are therefore of minor importance in determining facies distribution within the area.

Discussion of ecologic factors

Numerous studies of the foraminifera of the Gulf of Mexico have been reported in the recent literature (Bandy, 1954, 1956; Lankford (in Shepard, 1956); Lowman, 1949; Parker, Phleger, and Peirson, 1953; Phleger, 1954, 1955, 1956; Phleger and Parker, 1951; Phleger and Parker (in Galtsoff, 1954); and Post, 1951). On the basis of these reports and of the study reported here, it is apparent that there exist in the Gulf two broad areas of benthonic foraminiferal assemblages that are basically similar in terms of the species of which they are composed and of their ecologic systems. These are the open Gulf, with water masses of normal salinity and with relatively stable ecologic conditions, and the inshore areas, with ecologic conditions that are highly variable geographically and temporally. Within the Gulf of Mexico, the clear water off the west coast of Florida supports a benthonic foraminiferal fauna that is basically different from that of the turbid waters off Texas and Louisiana (Bandy, 1956, p. 189). As indicated by Bandy (1956, p. 189), the open Gulf benthonic foraminiferal fauna off the Florida coast has species of *Archaias*, *Asterigerina*, and *Amphistegina* as prominent components. Species of these genera are almost entirely absent from the turbid waters of the western Gulf. These open Gulf variations are also apparently reflected in the inshore benthonic foraminiferal faunas, although the differences do not seem as clear.

A tabulation has been made comparing the benthonic foraminiferal facies reported in the various recent studies of parts of the Gulf of Mexico. However, it failed to reveal any consistent usage in the terminology of foraminiferal facies, or any consistent definitions of boundaries in either the inshore or open Gulf areas. In addition, it is apparent that in some instances, different authors have used different lower taxa for the same morphologic form of foraminifera found in different parts of the Gulf of Mexico, thus complicating comparison of the various facies described. This problem is not within the scope of the present paper, but it is important to the understanding of the ecology and paleoecology of the foraminifera, and is therefore in need of investigation.

With respect to the inshore areas, the principal ecologic control of benthonic foraminiferal distribution appears to be variations in salinity (chlorinity) within the inshore areas studied. Bandy (1956), in his study of the ecology of northeastern Gulf of Mexico foraminifera, concluded that salinity variation was the controlling factor in the brackish-water habitat; and salinity control of the distribution of foraminifera in the area of San Antonio Bay, Texas, was implied (stated to be a result of the presence of the offshore islands) by Parker, Phleger, and Peirson (1953). Phleger, in his study of foraminiferal distribution in the Mississippi Sound area, concluded that the foraminiferal distribution was determined by the character of "water masses"

(Phleger, 1954, p. 603), which in turn are controlled by barrier islands and by high runoff [Phleger, 1954, p. 604]. In a discussion of the ecologic factors of the area, Phleger (1954, p. 603) states: "It is apparent that all of the following features of the marine environment are of *possible* [present author's italics] importance in varying degrees in different environments...." Lankford (in Shepard, 1956) attributed the distribution of foraminifera in the marginal sediments of the Mississippi Delta to salinity control.

Although it is certainly true that all ecologic factors in the environment are of *possible* importance in determining the foraminiferal distributions observed in various inshore areas, as indicated by Phleger, it seems quite *probable* that the *principal* ecologic control of the distribution of inshore brackish-water foraminifera is variation in salinity.

In the open Gulf (offshore) areas studied, various ecologic factors have been identified as controlling the distribution of benthonic foraminifera. Lowman (1949), in a study of the sedimentary facies of the Gulf of Mexico, attributed the benthonic foraminiferal distribution to salinity and depth gradients. Bandy (1954) attributed the benthonic foraminiferal species distribution (three gradational zones) in the shallow waters (less than 130 feet) of the Texas-Louisiana coast to salinity variation, stating (Bandy, 1954, p. 135): "The species involved apparently tolerate considerable temperature fluctuations." More recently, in a study of the benthonic foraminifera of the northeastern Gulf of Mexico, Bandy (1956) described five faunas, distributed to depths of 600 feet, which he attributed to the controlling factors of temperature, food, nutrients, turbulence, and turbidity, indicating that the "...temperature gradient is one of the important factors..." (Bandy, 1956, p. 189). Phleger (in Phleger and Parker, 1951), and Phleger and Parker (in Galtsoff, 1954), in studies of the benthonic foraminifera of the northwestern Gulf of Mexico to depths of more than 6500 feet, identified six depth facies that were apparently controlled by the temperature gradient, with the most marked faunal changes appearing at depths of 220 to 390 feet (top of the main (permanent) thermocline) and at depths of about 3200 feet (base of the main thermocline).

The distribution of benthonic foraminifera along the central Texas coast to depths of about 350 to 400 feet along selected traverses was reported by Phleger in 1956. The shallowest facies (to depths of 65 to 100 feet) were identified as controlled by the near-shore wave-turbulent zone. Phleger (1956, p. 122) attributed the boundary between the next two depth facies ("inner shelf" and "outer shelf") to the fluctuating boundary between near-shore and offshore water masses, at depths varying from 160 to 230 feet.

ECOLOGY AND DISTRIBUTION OF FORAMINIFERA

The foraminifera found in the 158 samples from the area studied were assigned to sixty-nine species distributed among thirty-three genera and fifteen families. With the exception of the three genera and species representing the Globigerinidae and Globorotaliidae, which are pelagic, the foraminifera described are benthonic forms. In the population-count work, the pelagic forms were counted with the benthonic forms in deriving the total population, since the number of pelagic foraminifera in any one sample was usually only one or two and rarely more than five.

Population density

The total population of foraminifera, or population density, in any environment is determined by the ecologic complex. In the area under study, the population density of an area is apparently controlled by the organic content of the bottom sediments and the salinity. Within any one area, the variation in population density is quite extreme (see Tables 1 through 4). The population density for the separate areas was determined by averaging the total populations of the samples counted for foraminifera in that area. The population-density figures for the various areas should allow rough comparison of areas with regard to population density, since the volumes of the samples obtained were reasonably uniform. The average population densities for the areas are as follows:

East Matagorda Bay inlet	1585
Peninsular marsh	1513
Mainland marshes	1328
Colorado River delta	1283
Matagorda "back" bay	1078
Littoral and beach	1007
Oyster Lake	956
East Matagorda Bay delta edge	753
Matagorda "fore" bay	688
East Matagorda "back" bay	672
East Matagorda "fore" bay	599
Matagorda Bay delta edge	521

These twelve areas can be grouped into three general categories, namely, open Gulf, bays, and marshes. When they are grouped in this manner, it is apparent that the marsh areas (including the Colorado

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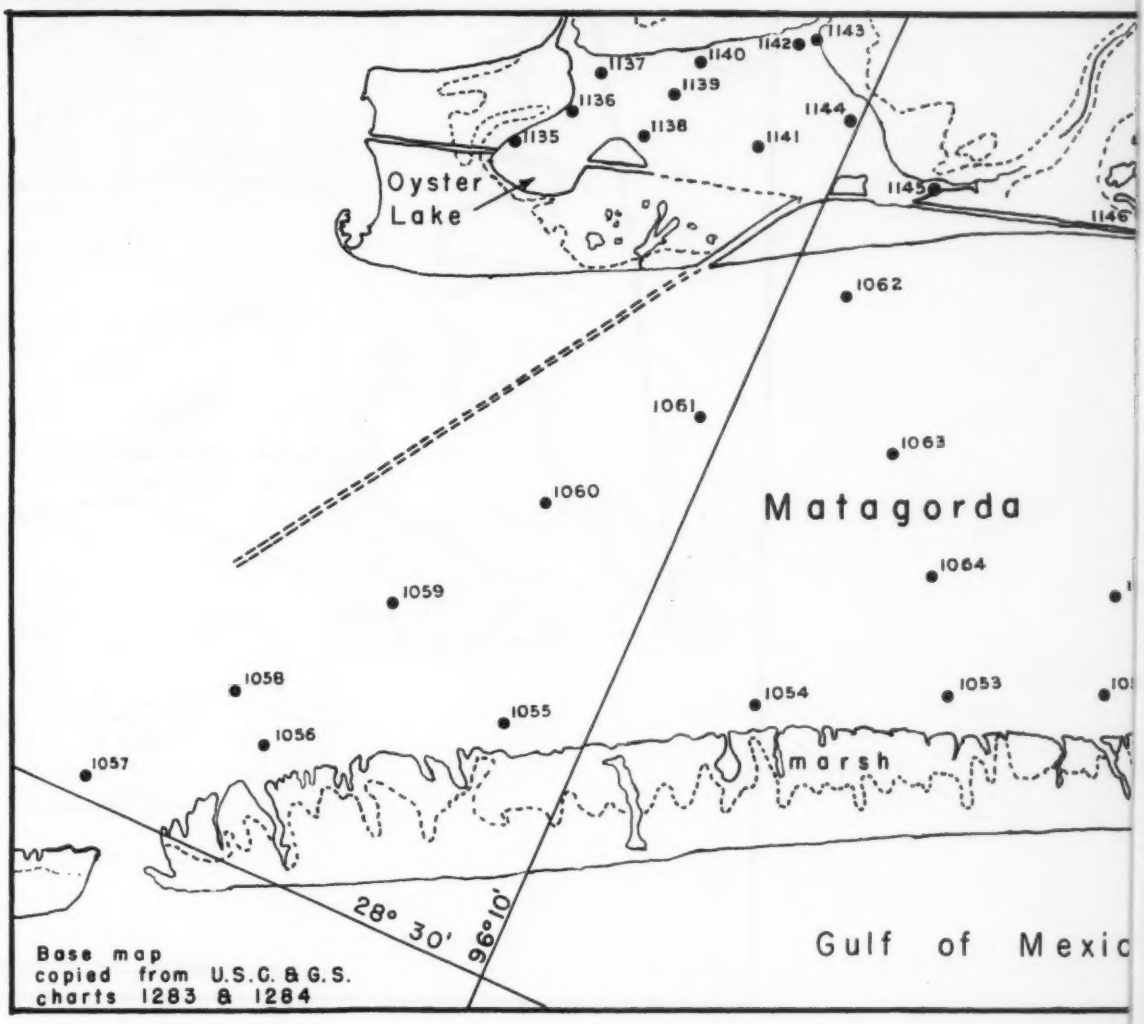
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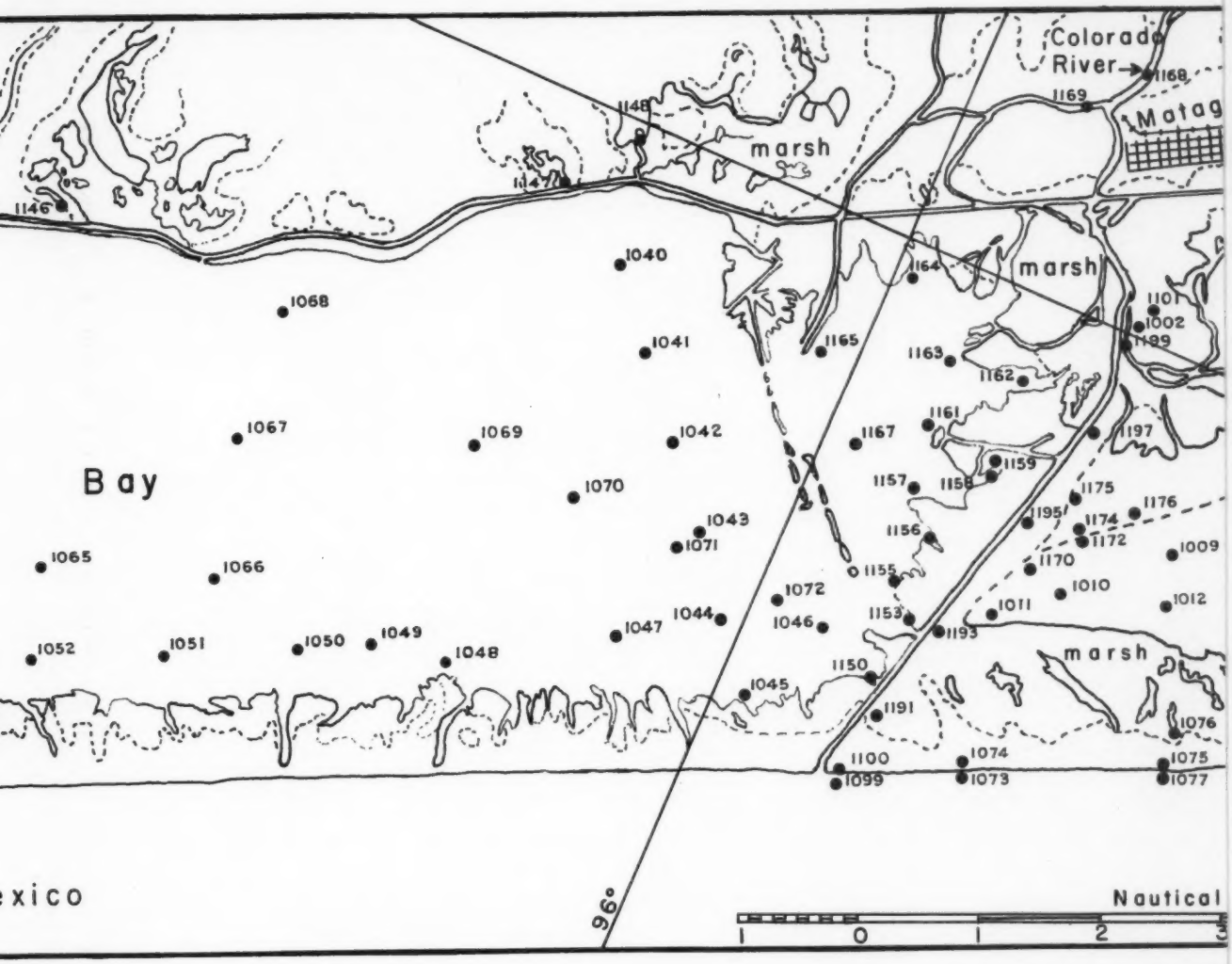
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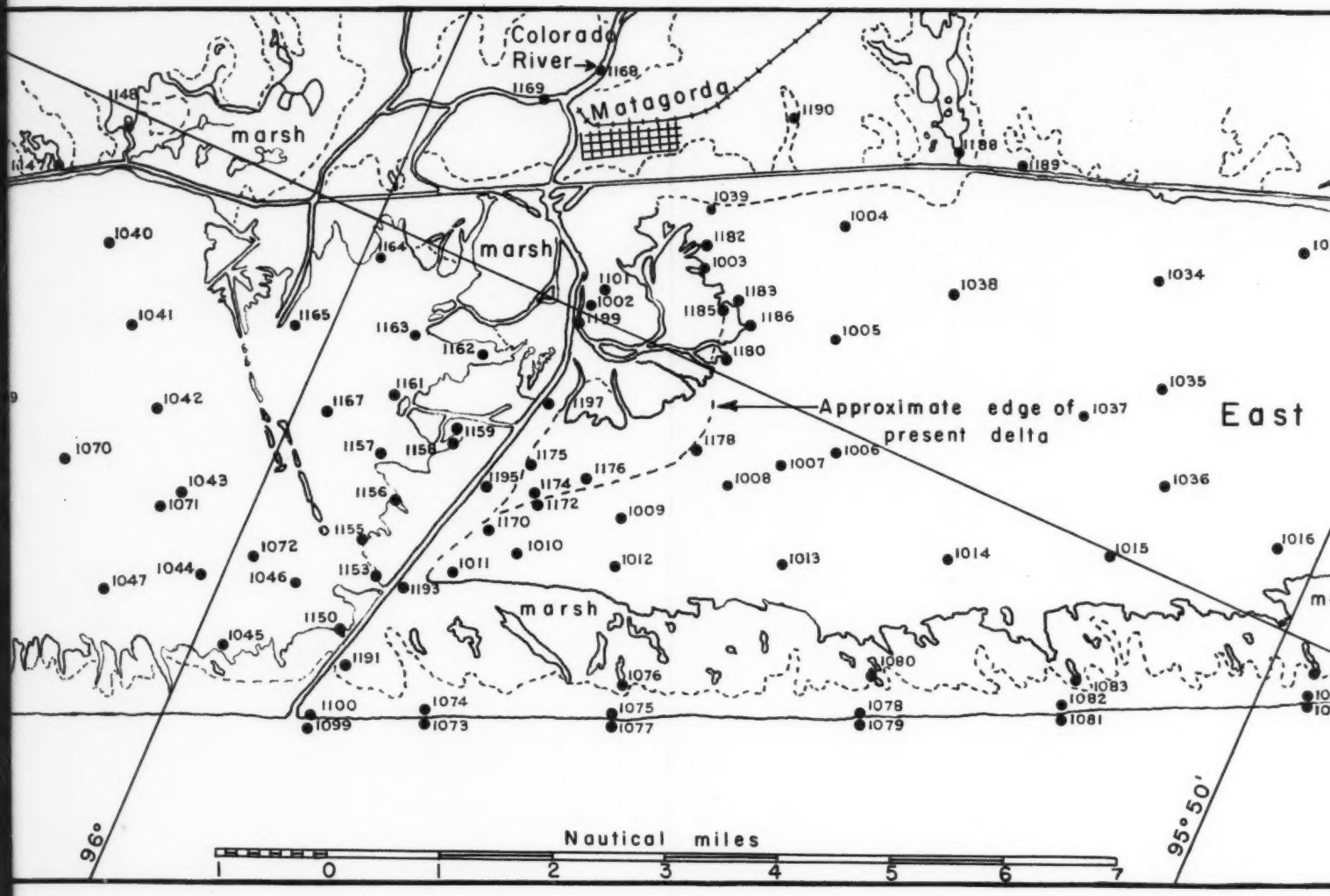
Colorado River
Matagorda
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Approximate edge of present delta
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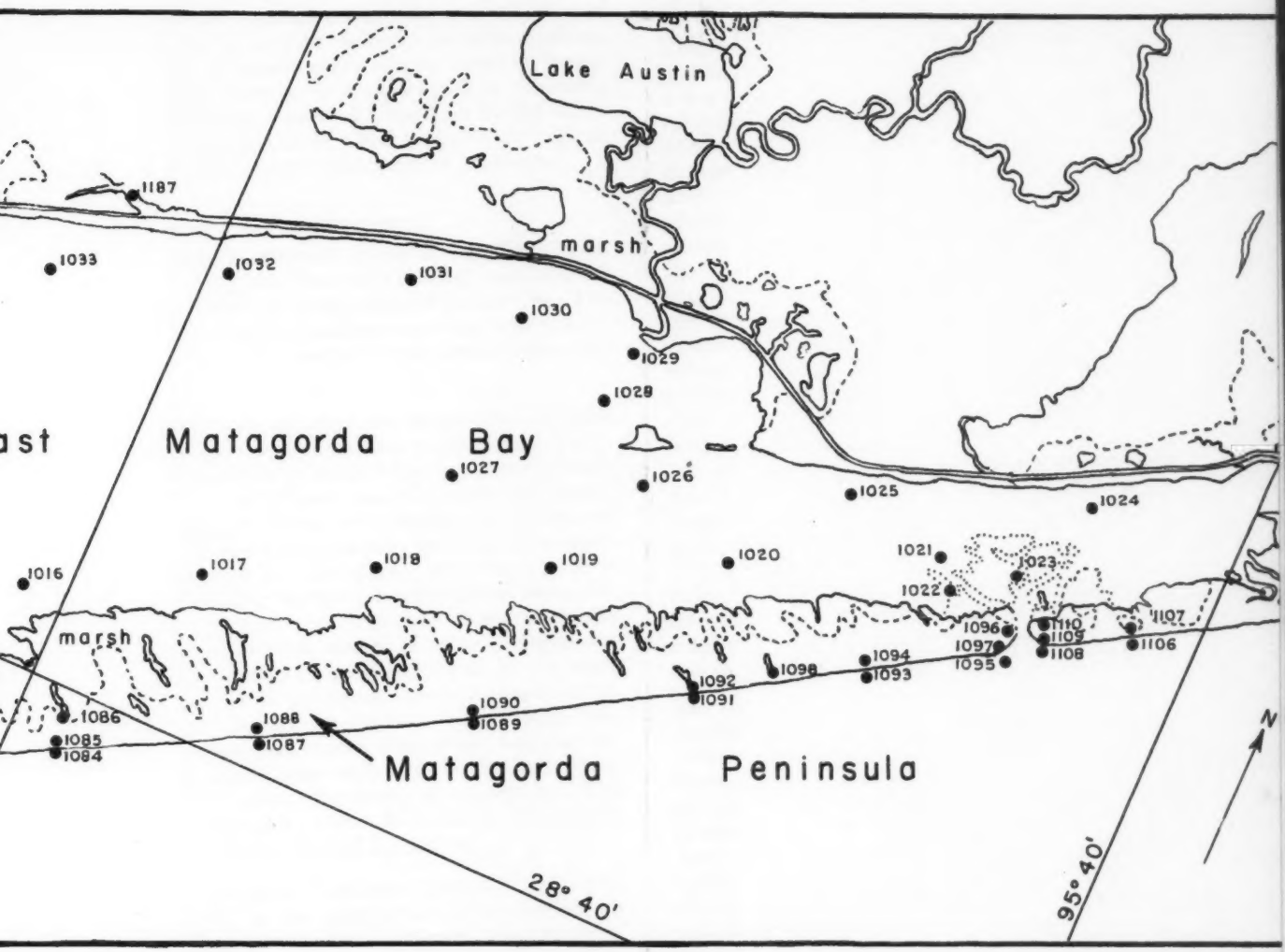
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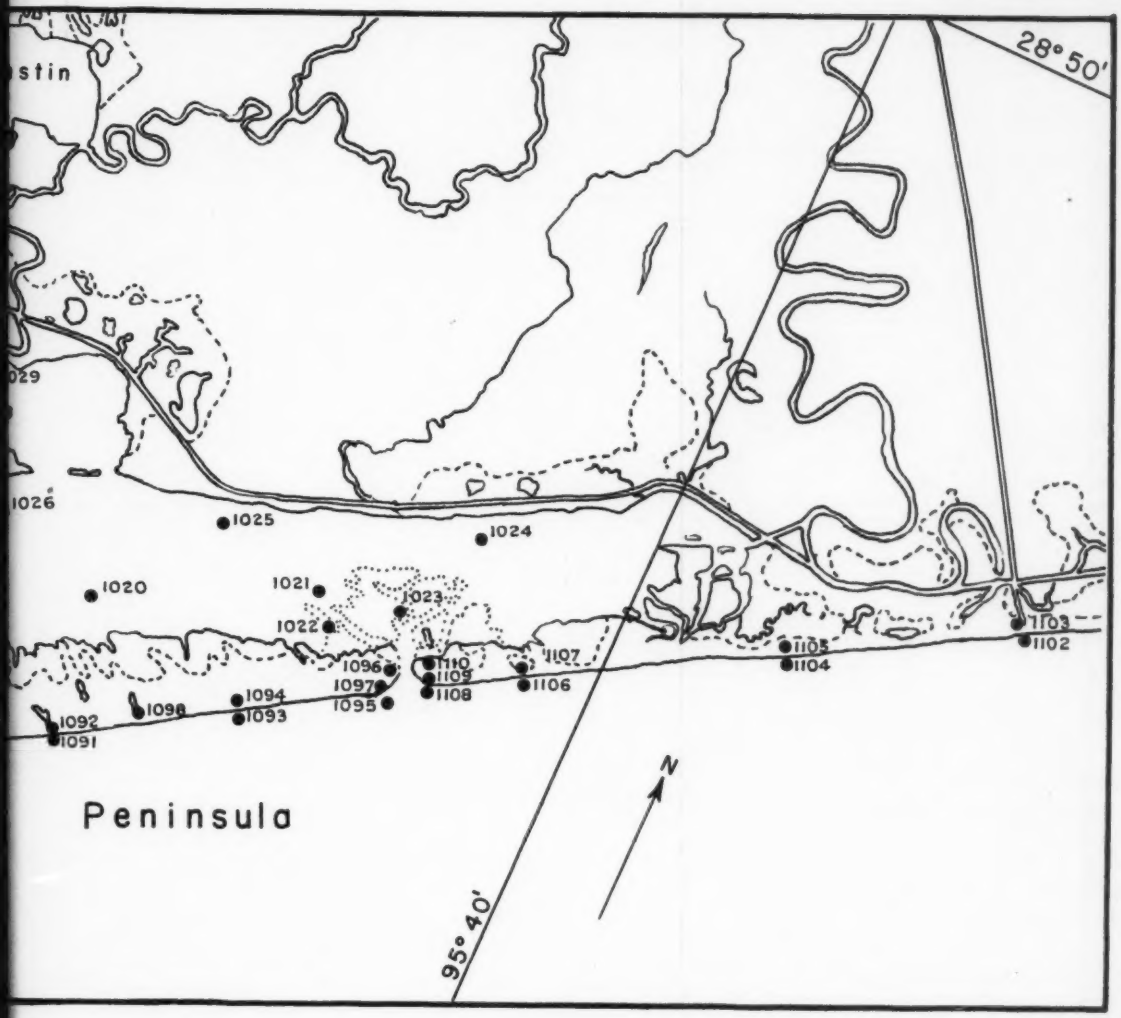
ast
Matagorda Bay
1027
1026
1025
1024
1016
1017
1018
1019
1020
1021
1023
1022
marsh
1096
1110
1109
1107
1097
1108
1106
1095
1094
1093
1098
1092
1091
1090
1089
1086
1088
1087
1085
1084
Matagorda Peninsula
N
28° 40'
95° 40'

TEXT-FIGURE 1



River delta) have the highest population densities, the bay areas the lowest, and the Gulf littoral and beach areas intermediate population densities. The maximum population densities are in the areas that have bottom sediments with the highest organic content, although the area of lowest organic content has intermediate population densities. With respect to salinity, areas of normal salinity have intermediate population densities, whereas areas of lowest salinity have the highest population densities, and areas of intermediate salinity have the lowest population densities. It is quite evident, therefore, that population density is controlled by the interaction of several factors, which probably are organic content, salinity, and abundance of predators.

Frequency facies and ecology of five species

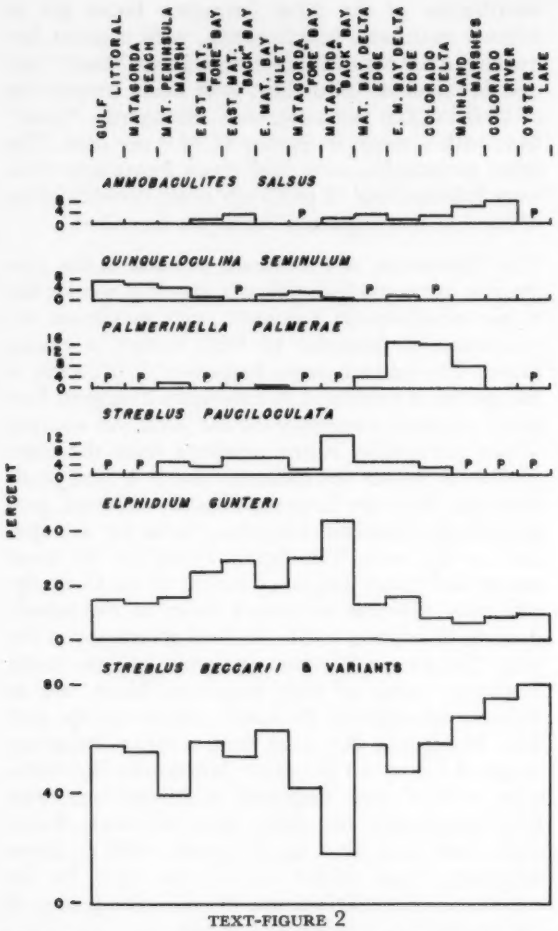
Of the species that were found to occur in all geographic areas, the five most abundant were selected for the statistical comparison of means test. The method of statistical analysis, equation, and general limitations of the method have already been discussed.

The relative mean frequency distribution of *Elphidium galvestonense* as presented in text-figure 3 suggests three levels of mean frequency (consequently three areas of different environmental conditions) for this species in the area studied. An analysis of the probability values resulting from the comparison of means test for this species indicates that it is highly probable that there are two rather restricted, significantly different frequency facies, with the majority of the areas studied showing no significant differences from one geographic area to the next. These two frequency facies, which are indicated in text-figure 5, are as follows: "fore" bays and Oyster Lake, with mean frequencies ranging between 5.4 and 7.8 per cent; and the Colorado River delta, with a mean frequency of 0.3 per cent. The other geographic areas had mean frequencies ranging between 0.6 and 2.3 per cent.

The relative mean frequency distribution of *Elphidium gunteri* in the geographic areas studied, as presented in text-figure 2, suggests four levels of mean frequency for the species in the area studied. An analysis of the probability values resulting from the comparison of means test indicates that it is highly probable that there are three significantly different, quite restricted frequency facies for this species in the area. Text-figure 6 illustrates the distribution of the three significantly different frequency facies of *Elphidium gunteri* in relation to the geographic areas. The mean frequency and geographic distribution of the three frequency facies are as follows: mainland marsh ponds, with a mean frequency of 6.0 per cent; East Matagorda "back" bay and Matagorda "fore" bay, with mean frequencies of 29.0 to 30.0 per cent; and Matagorda "back" bay, with a mean frequency of 44.0 per cent. The other geographic areas had mean frequencies that were intermediate (8 to 25 per cent) between those of the first two frequency facies just described.

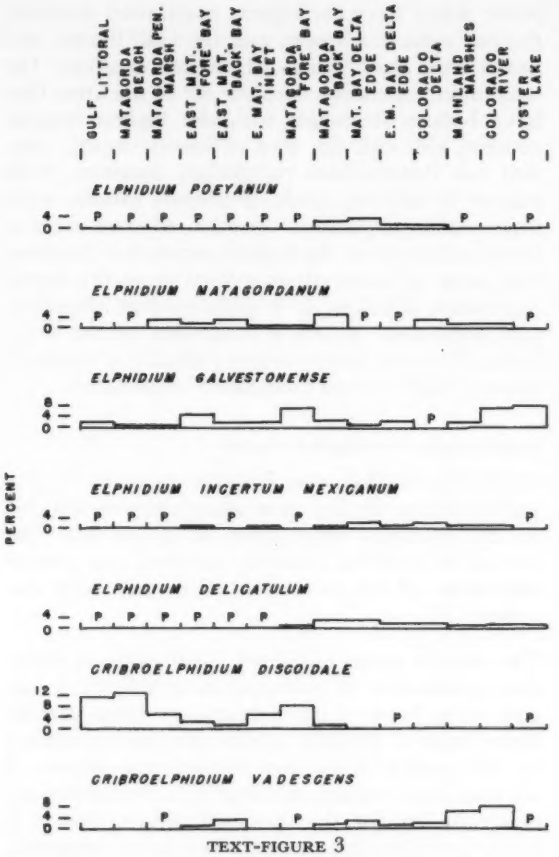
The distribution of *Palmerinella palmerae* in the geographic areas studied indicates that this species has a low salinity-range tolerance, with maximum development in brackish to fresh waters of marsh ponds. The relative mean frequency distribution of the species as presented in text-figure 2 suggests four levels of mean frequency for the area. An analysis of the probability values resulting from the comparison of means test indicates that it is most probable that there are three significantly different, geographically restricted frequency facies for this species in the area. Text-figure 7 depicts the areal extent and mean frequency ranges of the three significantly different frequency facies of *Palmerinella palmerae* in relation to the physical geography of the area. The geographic areas included, and the mean frequency range of each frequency facies, are as follows: Matagorda Peninsula marsh ponds and East Matagorda Bay inlet, with a mean frequency range of 1.0 to 1.6 per cent; Matagorda Bay delta edge, with a mean frequency of 3.6 per cent; and East Matagorda Bay delta edge, Colorado River delta, and mainland marsh ponds, with a mean frequency range of 8.5 to 17.5 per cent. In the remaining geographic areas, the mean frequency of this species was 0.3 per cent or less.

The relative mean frequency distribution of *Streblus pauciloculatus* in the geographic areas studied, as portrayed in text-figure 2, suggests three general levels of mean frequency for the area. An analysis of the probability values resulting from the comparison of means test indicates that it is most probable that there are two significantly different, somewhat restricted frequency facies of the species in the area. The geographic distribution and mean frequency ranges of the two significantly different frequency facies of *Streblus pauciloculatus* are illustrated in text-figure 8. The geographic distribution and the mean frequency of the two frequency facies delimited are as follows: Gulf littoral and beach, mainland marsh ponds, and Oyster Lake, with mean frequencies of 0.5 per cent or less; and Matagorda "back" bay, with a mean frequency of 15.6 per cent. The other geographic areas studied had mean frequencies ranging from 1.6 to 5.7 per cent.



TEXT-FIGURE 2

Relative mean frequencies of some of the more important foraminifera distributed to geographic areas from which samples were collected.

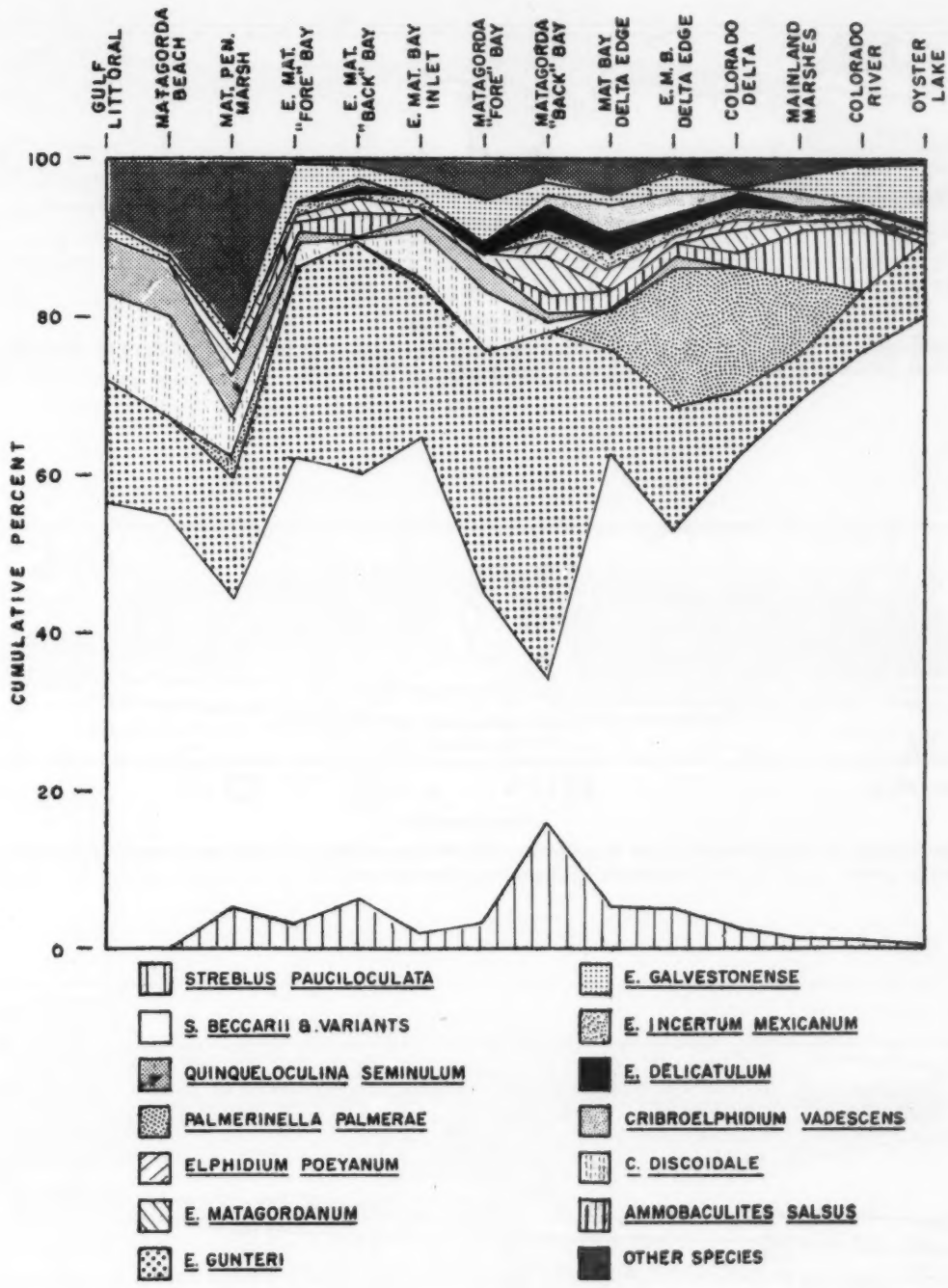


TEXT-FIGURE 3

Relative mean frequencies of some of the more important foraminifera distributed to geographic areas from which samples were collected.

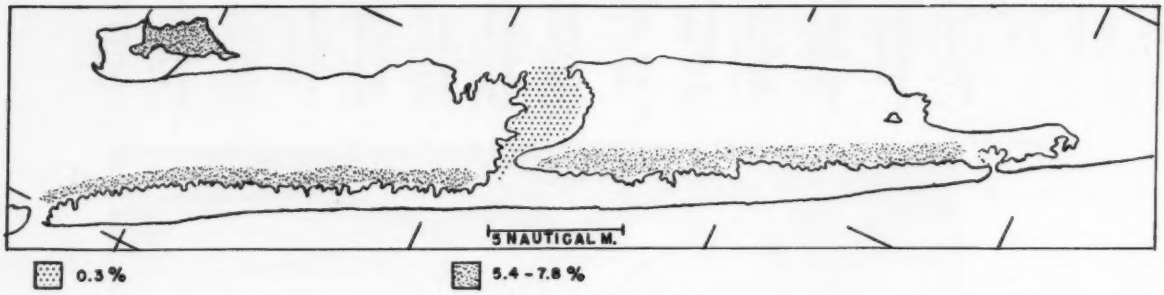
Streblus beccarii and variants, in terms of mean frequency, was the dominant species in all geographic areas except Matagorda "back" bay, where *Elphidium gunteri* was the dominant species. The relative mean frequency distribution of *Streblus beccarii* and variants in the geographic areas presented in text-figure 2 suggests two or possibly three levels of mean frequency for the area. A study of the probability values resulting from the comparison of means test indicates that it is highly probable that there are at least two significantly different, highly restricted frequency facies of the species, with limited geographic variation. The geographic distribution and mean frequency ranges of the two significantly different frequency facies of *Streblus beccarii* and variants are presented in text-figure 9. These two frequency facies have the following geographic distribution and mean frequencies: Matagorda "back" bay, with a mean frequency of 17.7 per cent; and Oyster Lake, with a mean frequency of 80.1 per cent.

Considering the foraminiferal facies distribution of the five species just discussed, it is possible to describe eleven or possibly twelve significantly different foraminiferal facies in the area studied. The foraminiferal facies correspond to the geographic areas as indicated in text-figure 10, and are distinguished as follows: Gulf littoral and beach, mean frequency of *Streblus pauciloculatus* of 0.1 to 0.5 per cent; Matagorda Peninsula marsh and East Matagorda Bay inlet, mean frequency of *Palmerinella palmerae* of 1.0 to 1.6 per cent; East Matagorda "fore" bay, mean frequency of *Elphidium galvestonense* of 5.4 to 7.8 per cent; East Matagorda "back" bay, mean



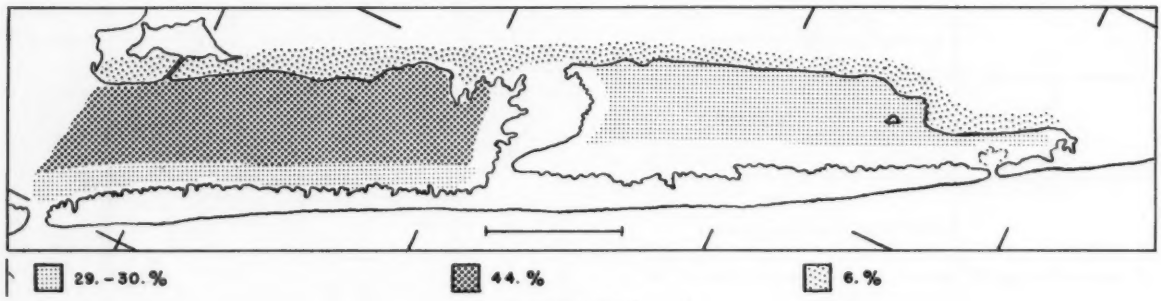
TEXT-FIGURE 4

Cumulative mean frequencies of the more important foraminifera distributed to geographic areas from which samples were collected.



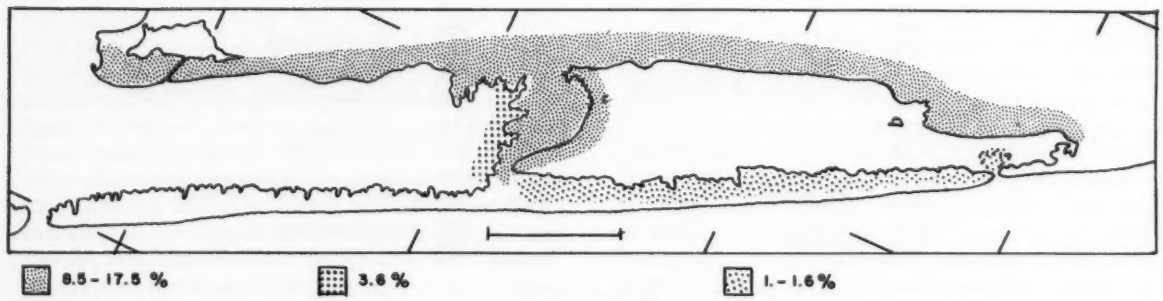
TEXT-FIGURE 5

Areas significantly different from all other sample areas studied according to mean percentages of total population for *Elphidium galvestonense*, based on the Student "t" comparison of means test.



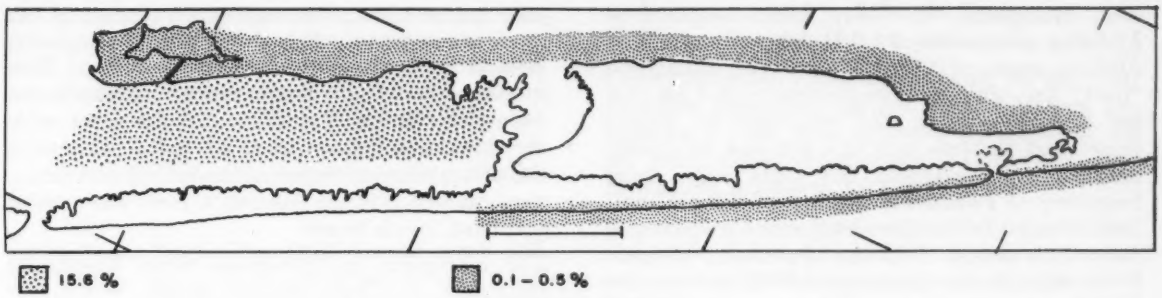
TEXT-FIGURE 6

Areas significantly different from all other sample areas studied according to mean percentages of total population for *Elphidium gunteri*, based on the Student "t" comparison of means test.



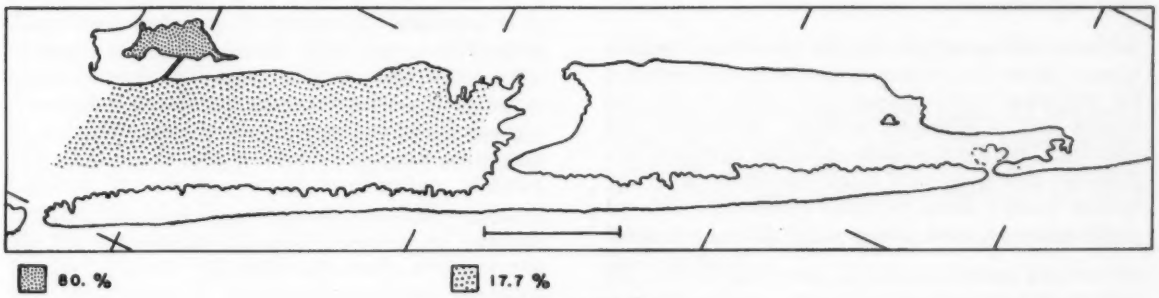
TEXT-FIGURE 7

Areas significantly different from all other sample areas studied according to mean percentages of total population for *Palmerinella palmerae*, based on the Student "t" comparison of means test.



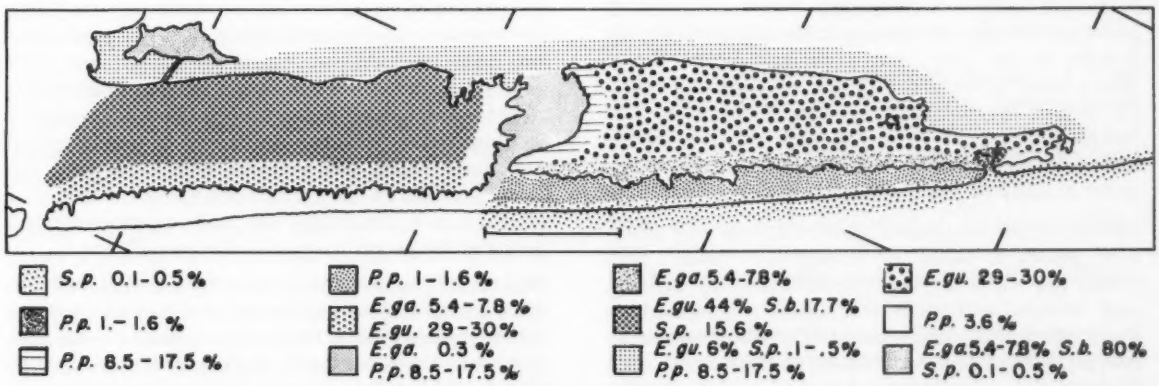
TEXT-FIGURE 8

Areas significantly different from all other sample areas studied according to mean percentages of total population for *Streblus pauciloculatus*, based on the Student "t" comparison of means test.



TEXT-FIGURE 9

Areas significantly different from all other sample areas studied according to mean percentages of total population for *Streblus beccarii* and variants, based on the Student "t" comparison of means test.



TEXT-FIGURE 10

Foraminiferal facies based on significantly different areas of the five species analyzed statistically.

frequency of *Elphidium gunteri* of 29.0 to 30.0 per cent; Matagorda "fore" bay, mean frequency of *Elphidium galvestonense* of 5.4 to 7.8 per cent, and of *Elphidium gunteri* of 29.0 to 30.0 per cent; Matagorda "back" bay, with mean frequencies of 44.0 per cent for *Elphidium gunteri*, 17.7 per cent for *Streblus beccarii* and variants, and 15.6 per cent for *Streblus pauciloculatus*; Matagorda Bay delta edge, mean frequency of *Palmerinella palmerae* of 3.6 per cent; East Matagorda Bay delta edge, mean frequency of *Palmerinella palmerae* of 8.5 to 17.5 per cent; Colorado River delta, mean frequencies of 0.3 per cent for *Elphidium galvestonense* and 17.5 per cent for *Palmerinella palmerae*; mainland marsh ponds, with mean frequencies of 6.0 per cent for *Elphidium gunteri*, 0.1 to 0.5 per cent for *Streblus pauciloculatus*, and 8.5 to 17.5 per cent for *Palmerinella palmerae*; and Oyster Lake, with mean frequencies of 5.4 to 7.8 per cent for *Elphidium galvestonense*, 80.1 per cent for *Streblus beccarii* and variants, and 0.1 to 0.5 per cent for *Streblus pauciloculatus*.

An examination of the figures presenting the frequency facies distribution of the five species selected for statistical study reveals that each of the five species has a different ecologic preference and tolerance. With the possible exception of *Palmerinella palmerae*, the frequency facies distributions of the species studied show no direct correlation with the geographic variation of any single ecologic factor.

Palmerinella palmerae exhibits a definite preference for the marsh environment, where the salinity range is probably from 1 or 2 parts per thousand to 5 or 10 parts per thousand. In the area studied, this species had a maximum mean frequency of 17.5 per cent in the East Matagorda Bay delta-edge area (62.0 per cent in sample 1180).

The distribution of frequency facies of *Elphidium galvestonense* indicates maximum development for the species in the "fore" bay areas and Oyster Lake, where there are neither minimal nor maximal values for any of the ecologic variables of the area. The minimal frequency of the species is found on the Colorado River delta, which may have the lowest water salinity of any geographic area studied.

Similarly, the maximum mean frequency of *Elphidium gunteri* is found in Matagorda "back" bay, which has water of relatively intermediate salinity, and bottom sediments of relatively intermediate grain size and organic content. The minimum mean frequency of the species is found in the marsh ponds of the mainland adjacent to the bays, with all other geographic areas having mean frequency values intermediate between these two extremes.

The distribution of frequency facies of *Streblus pauciloculatus* indicates an ecologic preference of the species for areas of relatively intermediate salinity, median grain-size, and organic content. This species reached its maximum mean frequency in the Matagorda "back" bay area (15.6 per cent), with very low mean frequencies of 0.1 to 0.5 per cent in the normal marine waters of the littoral and beach areas, as well as in the brackish to fresh water of the mainland marsh ponds.

The maximum and minimum mean frequencies (80.1 and 17.7 per cent) of *Streblus beccarii* and variants occurred in Oyster Lake and Matagorda "back" bay, respectively. Both of these areas are relatively intermediate in terms of the range of variation of the ecologic factors of salinity, organic content, and median grain-size of the bottom sediments.

All of the five species selected for special statistical study were found to occur in at least one sample (in most instances in nearly all samples) from each geographic area, which indicates that the range of tolerance of these species is equal to or exceeds the range of ecologies. As indicated by text-figures 5 through 9 and the previous discussions, the areas of maximum frequency for each species are quite apparently determined by a complex of ecologic factors, which are not necessarily similar for any two species. The following ecologic factors are apparently the most important in determining the areas of maximum frequency of any of the five species studied: salinity, turbulence, organic content, and associated fauna and flora.

Foraminiferal facies

The variations in frequency of a species, and therefore a foraminiferal facies, are gradational from one geographic area to the next. Considering the daily, the seasonal, and perhaps the yearly fluctuations in the physical environment of any one area, this gradational aspect of the distribution of the foraminifera is not unexpected. For purposes of convenience in illustration, the facies illustrated in text-figure 10 are shown with sharp boundaries. Likewise, the exact position of the facies boundaries on this map (if these are definable) are only approximate in terms of the larger map shown in text-figure 1.

The descriptions of the foraminiferal facies of the area which follow will group the species into the following categories: Diagnostic species—those species whose mean relative frequency for the area is significantly different, according to statistical tests, from the mean of other areas; common species—those species which are present in all or in most

samples of the area, with mean frequencies for the area of more than 1 per cent; and rare species—those species which are found to constitute not more than 1 per cent of the population in the area concerned and/or are restricted to the area and possibly to one or two other areas. Percentage figures following the species listed are mean relative percentages of the total population for the species in the particular facies.

Littoral-beach facies: The Gulf littoral zone and Matagorda Peninsula beach areas comprise the physical framework of this facies. The facies is distinguished by and composed of the following species of foraminifera:

Diagnostic species: *Streblus pauciloculatus*, significantly different mean frequency of 0.1 per cent. This species was found in only three samples in this facies.

Common species: *Cribroelphidium discoidale*, 11.9 per cent; *Cribroelphidium* cf. *koeboeense*, 1.4 per cent; *Elphidium galvestonense*, 1.2 per cent; *Elphidium gunteri*, 14.0 per cent; *Quinqueloculina lamarckiana*, 1.0 per cent; *Quinqueloculina seminulum*, 6.6 per cent; and *Streblus beccarii* and variants, 56.2 per cent.

Rare species: *Massilina peruviana*, *Nonion pauciloculum*, *Quinqueloculina rhodiensis*, and *Rolshausenia rolshauseni*.

Offshore-bar marsh facies: The marshes and ponds of the central part of Matagorda Peninsula comprise the area in which this facies is developed. This facies is distinguished by and composed of the following species of foraminifera:

Diagnostic species: *Palmerinella palmerae*, 1.0 per cent.

Common species: *Cribroelphidium discoidale*, 4.7 per cent; *Elphidium gunteri*, 15.9 per cent; *Elphidium matagordanum*, 2.5 per cent; *Massilina protea*, 4.6 per cent; *Miliammina fusca*, 1.5 per cent; *Quinqueloculina rhodiensis*, 4.7 per cent; *Quinqueloculina seminulum*, 5.3 per cent; *Streblus beccarii* and variants, 39.4 per cent; and *Streblus pauciloculatus*, 4.8 per cent.

Rare species: *Cribroelphidium koeboeense*, *Elphidium advenum*, *Elphidium galvestonense*, and *Rolshausenia rolshauseni*.

"*Back*" *bay facies—type 1:* This type of "back" bay facies is developed in the bays which have relatively free circulation with normal marine waters, such as Matagorda Bay, as compared with the very restricted circulation of bays such as East Matagorda Bay. In the area studied, this facies is developed in the central and mainland margin areas of Matagorda Bay. This facies is distinguished by and composed of the following species of foraminifera:

Diagnostic species: *Elphidium gunteri*, 44.0 per cent; *Streblus beccarii* and variants, 17.7 per cent; and *Streblus pauciloculatus*, 15.6 per cent.

Common species: *Ammobaculites salsus*, 2.0 per cent; *Elphidium delicatulum*, 3.3 per cent; *Elphidium galvestonense*, 1.7 per cent; *Elphidium matagordanum*, 5.0 per cent; *Nonion* cf. *granosum*, 2.1 per cent; and *Rolshausenia rolshauseni*, 1.0 per cent.

Rare species: *Cribroelphidium discoidale*, *Cribroelphidium vadescens*, *Elphidium advenum*, *Elphidium incertum mexicanum*, *Elphidium oceanicum*, and *Quinqueloculina seminulum*.

"*Back*" *bay facies—type 2:* As indicated in the discussion of type 1 of this facies, type 2 is developed in the central and mainland margin portions of bays such as East Matagorda Bay, which have very restricted circulation with normal marine water masses. This facies is distinguished by and composed of the following species of foraminifera:

Diagnostic species: *Elphidium gunteri*, 29.0 to 30.0 per cent.

Common species: *Ammobaculites salsus*, 3.2 per cent; *Elphidium galvestonense*, 1.7 per cent; *Elphidium matagordanum*, 2.1 per cent; *Streblus beccarii* and variants, 53.7 per cent; and *Streblus pauciloculatus*, 5.7 per cent.

Rare species: *Elphidium incertum mexicanum* and *Elphidium poeyanum*.

"*Fore*" *bay facies—type 1:* This type of "fore" bay facies is developed in the offshore bar or peninsular margins of bays, such as Matagorda Bay, which have relatively free circulation with normal water masses. This facies is distinguished by and composed of the following species of foraminifera:

Diagnostic species: *Elphidium galvestonense*, 5.4 to 7.8 per cent; and *Elphidium gunteri*, 29.0 to 30.0 per cent.

Common species: *Cribroelphidium discoidale*, 7.6 per cent; *Massilina protea*, 1.3 per cent; *Quinqueloculina costata*, 1.9 per cent; *Quinqueloculina seminulum*, 2.6 per cent; *Streblus beccarii* and variants, 42.2 per cent; *Streblus pauciloculatus*, 2.5 per cent.

Rare species: *Hanzawaia strattoni*, *Elphidium delicatulum*, *Elphidium matagordanum*, *Elphidium poeyanum*, *Quinqueloculina poeyana*, and *Quinqueloculina rhodiensis*.

"*Fore*" *bay facies—type 2:* In distinction to type 1 of the "fore" bay facies, type 2 is developed in the offshore bar or peninsular margins of bays, such as East Matagorda Bay, which have relatively restricted circulation of water with normal marine

water masses. This facies is distinguished by and composed of the following species of foraminifera:

Diagnostic species: *Elphidium galvestonense*, 5.4 to 7.8 per cent.

Common species: *Cribroelphidium discoidale*, 1.9 per cent; *Elphidium incertum mexicanum*, 1.1 per cent; *Elphidium gunteri*, 25.1 per cent; *Streblus beccarii* and variants, 58.7 per cent; and *Streblus pauciloculatus*, 2.8 per cent.

Rare species: *Ammobaculites salsus*, *Elphidium matagordanum*, *Elphidium poeyanum*, *Quinqueloculina candeiana*, *Quinqueloculina rhodiensis*, and *Quinqueloculina seminulum*.

Bay delta edge facies—type 1: The shallow waters of the bay margins of the Colorado River delta support a foraminiferal fauna that is distinct from the bay faunas and from the fauna of the delta itself. Type 1 of the bay delta edge facies is represented by the delta edge margin of a bay, such as Matagorda Bay, which has relatively free circulation of water with marine water masses. This facies is composed of and distinguished by the following species of foraminifera:

Diagnostic species: *Palmerinella palmerae*, 3.6 per cent.

Common species: *Ammobaculites salsus*, 3.2 per cent; *Cribroelphidium vadescens*, 3.0 per cent; *Elphidium delicatulum*, 2.5 per cent; *Elphidium incertum mexicanum*, 1.9 per cent; *Elphidium gunteri*, 12.6 per cent; *Elphidium poeyanum*, 2.4 per cent; *Nonion* cf. *granosum*, 1.8 per cent; *Streblus beccarii* and variants, 58.4 per cent; and *Streblus pauciloculatus*, 5.3 per cent.

Rare species: *Ammobaculites dilatatus*, *Arenoparrella mexicana*, and *Elphidium galvestonense*.

Bay delta edge facies—type 2: Type 2 of the bay delta edge facies is distinguished from type 1 in that type 2 is represented by a bay, such as East Matagorda Bay, which has relatively restricted circulation of water with normal marine water masses. This facies is distinguished by and composed of the following species of foraminifera:

Diagnostic species: *Palmerinella palmerae*, 8.5 to 17.5 per cent.

Common species: *Cribroelphidium vadescens*, 2.5 per cent; *Elphidium delicatulum*, 1.5 per cent; *Elphidium galvestonense*, 2.3 per cent; *Elphidium gunteri*, 16.2 per cent; *Elphidium poeyanum*, 1.2 per cent; *Streblus beccarii* and variants, 47.8 per cent; and *Streblus pauciloculatus*, 4.6 per cent.

Rare species: *Ammobaculites dilatatus*, *Ammobaculites salsus*, *Elphidium incertum mexicanum*, *Nonion* cf. *granosum*, and *Quinqueloculina seminulum*.

Delta facies: The Colorado River delta, separating Matagorda Bay and East Matagorda Bay, is the area in which this facies is developed. The facies is composed of and differentiated by the following species of foraminifera:

Diagnostic species: *Elphidium galvestonense*, 0.3 per cent; and *Palmerinella palmerae*, 8.5 to 17.5 per cent.

Common species: *Ammobaculites salsus*, 1.9 per cent; *Elphidium delicatulum*, 1.5 per cent; *Elphidium incertum mexicanum*, 1.4 per cent; *Elphidium gunteri*, 7.9 per cent; *Elphidium matagordanum*, 3.1 per cent; *Nonion* cf. *granosum*, 1.3 per cent; *Streblus beccarii* and variants, 58.5 per cent; and *Streblus pauciloculatus*, 3.1 per cent.

Rare species: *Arenoparrella mexicana* and *Trochammina inflata*.

Mainland marsh ponds facies: This facies is developed in the brackish to nearly fresh-water marsh ponds of the mainland, found in a belt of varying width adjacent to the bays. The facies is distinguished by and composed of the following species of foraminifera:

Diagnostic species: *Elphidium gunteri*, 6.0 per cent; *Palmerinella palmerae*, 8.5 to 17.5 per cent; and *Streblus pauciloculatus*, 0.1 to 0.5 per cent.

Common species: *Ammobaculites salsus*, 5.6 per cent; *Cribroelphidium vadescens*, 1.4 per cent; *Elphidium incertum mexicanum*, 1.2 per cent; *Elphidium galvestonense*, 2.3 per cent; and *Streblus beccarii* and variants, 67.8 per cent.

Rare species: *Arenoparrella mexicana*, *Elphidium delicatulum*, *Elphidium matagordanum*, *Miliammina fusca*, *Recurvoides* sp., and *Streblus pauciloculatus*.

Marginal brackish lake facies: Oyster Lake, which is located on the mainland, is separated from Matagorda Bay on the south and west by low marshy areas, and is representative of the facies. The lake has restricted circulation of water with that of the bay through the two intercoastal waterway channels, which are dredged through these low marshy zones. The facies is composed of and distinguished by the following species of foraminifera:

Diagnostic species: *Elphidium galvestonense*, 5.4 to 7.8 per cent; *Streblus beccarii* and variants, 80.1 per cent; and *Streblus pauciloculatus*, 0.1 to 0.5 per cent.

Common species: *Elphidium gunteri*, 9.3 per cent.

Rare species: *Ammobaculites salsus* and *Elphidium poeyanum*.

TABLE 1

DISTRIBUTION OF FORAMINIFERA AND SEDIMENT-SIZE DATA OF SURFACE-SEDIMENT SAMPLES FROM THE GULF LITTORAL ZONE, MATAGORDA PENINSULA BEACH, MATAGORDA PENINSULA MARSH PONDS, AND EAST MATAGORDA BAY INLET

Grain sizes in millimeters. Species recorded as per cent of total population.
Total population figures that are underlined are estimates based on counts of 400 or more specimens.

| AREA | GULF LITTORAL | | |

TABLE 2

DISTRIBUTION OF FORAMINIFERA AND SEDIMENT-SIZE DATA OF SURFACE-SEDIMENT SAMPLES FROM MATAGORDA BAY

Grain size given in millimeters. Species recorded as per cent of total population.

AREA	MATAGORDA BAY																																				
SAMPLE NUMBER	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1161	1165	1167
MEDIAN GRAIN SIZE					.011	.038		.110	.031		.111	.113	.108	.105	.100	.093		.120					.036		.025												
SORTING COEFFICIENT					1.24	1.17		1.12	1.24		1.21	1.11	1.11	1.20	1.14	1.11		1.17					1.15		1.13												
STANDARD DEVIATION					2.08	1.66		0.47	1.58		0.90	0.35	0.60	0.85	0.62	0.65		0.98					0.72		0.98												
DEPTH OF WATER	3.0	4.0	4.5	4.0	4.0	3.5	2.5	8.0	2.5	6.0	3.5	4.0	3.0	3.5	3.0	13.0	3.0	2.5	10.5	15.0	13.0	6.0	2.5	8.0	13.0	10.0	6.5	3.0	4.0	5.0	4.5	3.0	1.5	2.0	2.0
TOTAL POPULATION	3102	93	177	216	1713	525	18	3744	205	272	604	436	631	235	1021	513	377	359		175	350		1139	281	1675		2841										
Ammobaculites arenaria	1.1																																				
A. dilatatus	.5					.4									.1							—		.5	.1	—								—	—	—
A. salsus	13.4		2.3	2.3	.4		11.1	.8												1.7	.3		1.2				.2										
Arenoparrella mexicana																							.2														
Bolivina striatula																																					
Hamzawaia strattoni	.1		.6		.5	.4		1.1	.5		.2	.2	.6	.4	.1			.6							.2		.1									
Cribroelphidium discoidale	.5	2.2		1.9	1.4	6.7		5.0	6.8	5.9	5.5	5.7	7.5	8.5	8.0	10.5	8.0	13.1	—				.9	.6	—	1.5	—		—	—	—	—				
C. cf. koebaeense																											—			—							
C. kugleri	.2	1.1			.4			.1												1.1	4.8	—			.1	—			—				—				
C. vadescens		2.2			.5			.8											—		.9	—	.2		.1		.6	—						—	—	—	
Discorinopsis aguayoi																											—										
Elphidium advenum	.3		.6	.5				.4					.2		1.3				—	.6	.3		.7			—	.1	—									
E. delicatulum	3.5	6.5	3.4	4.2	.5	.8		.4	2.9		1.7	.9		.4	.5				—	2.9	2.5	—	3.5	2.3	1.4		6.0	—	—	—			—	—	—	—	
E. cf. fimbriatulum																			—																		
E. incertum mexicanum	2.0	2.2	5.1	.9	.5	.6		.9	.5							.2			—			—	.5				7	—	—	—	—			—	—	—	—
E. galvestonense	1.2		1.7	2.8		.8	11.1	3.8	6.3	11.0	4.6	6.2	6.5	8.5	8.3	5.7	7.2	2.2	—	5.1		—	1.2		.3	—	2.1	—	—	—	—	—		—	—	—
E. gunteri	26.8	51.6	40.1	43.5	43.4	28.9	27.8	32.5	30.7	20.6	34.7	32.1	29.7	31.9	36.8	28.7	30.2	29.0	—	28.6	59.5	—	44.2	48.4	61.0	—	38.5	—	—	—	—	—	—	—	—	—
E. matagordanum	5.7	4.3	4.5	2.3	10.7	3.1	11.1	1.3									2.9	1.1		2.0			6.0	3.2	3.6	—	12.1	—	—	—						
E. oceanicum	5.0				1.6	.2																			.3		1.1			—	—			—	—	
E. poeyanum	2.4		.6	1.4	1.8			.2		2.2	.2		.8	.4	.4				—		1.1		3.7	.5	.1	—	6.0	—	—	—	—		—	—		—
E. tumidum								.1																	.8					—						
Globigerina bulloides	.1							.1							.1	.2								.9													
Globigerinella aequilateralis						.2																								—							
Globotruncana cf. linnaeana	.1							.1																													
Guttulina australis												.2																									
Massilina peruviana								.1				.7			.8		.3												—								
M. protea						.2		.7		5.5	.3		2.5	.4	1.4	2.3		3.6			1.4		.3		.9		.5			—	—						
Miliamming fusca								.1										.3			.3																
Nonion germanicum				.5							.3														.1					—		—	—		—		
N. cf. granosum	5.0		6.8	2.3	1.9	1.5		6													.3		2.0	.9	1.2	—	2.8	—	—	—			—	—	—	—
N. pauciloculum																.4																					
Palmerinella palmerae	.3					1.0		.4					.3		.1		.3	.8					.8				.1							—	—		—
Psammonyx sp.																		.3																	—	—	—
Quinqueloculina cf. bicostata	.1																																			—	
Q. candeiana	.7					1.3			.5	.4					.3			1.4	—				.3			—	.1			—						
Q. costata	.2							.8	.5	5.5		.7	8.4	1.3	1.3	2.7		3.4					.3		.4	—	.1			—			—		—	
Q. cultrata																										—										
Q. lamarckiana								.4					.3					.3							.1	—				—						
Q. poeyana								.3	.3			.2		.4	1.0	.8		.8	—						.1					—			—			
Q. rhodiensis	.5					.8		1.2		2.9			2.1		1.2						.3		1.3		.2	—	.3									
Q. sawanensis																					.6		1.0		.2					—						
Q. seminulum	.2		1.1	1.4	.7	1.1		2.0	2.0	1.5	1.0	2.8	4.1	4.7	3.2	7.0		5.0	—		1.4		.5		.8	—	.4	—		—		—	—			
Q. seminulum jugosa	.2							.2											—								.1		—	—						
Q. cf. subcarinata										.7																											
Q. wiesneri											.3					.2			—		.3				.1												
Rolshausenia rolshausseni		1.1	.6	.5	4.7	1.7		2.1		.7								.8			.6		2.3		.6		.8	—								—
Spirillina vivipara													.5																								
Spiroloculina manifesta	.3																					—								—						
Strebius beccarii & vars.	14.2	19.0	2.90	25.0	19.0	48.2	33.0	37.1	42.0	40.0	50.0	48.2	37.0	40.0	35.0	43.2	31.1	36.0	—	6.3	9.7	—	21.7	24.0	23.3	—	10.9	—	—	—	—	—	—	—	—	—
S. pauciloculata	14.8	9.7	10.2	11.1	12.4	5.3	5.6	6.9	6.3	2.9	1.7	.9	1.0	1.7	.3	.2	.5	1.7	—	50.0	16.0	—	8.0	18.0	3.2	—	18.0	—	—	—	—	—	—	—	—	—
Textularia aura								.2																													
T. earlandi								.2																													

For several reasons, the salinity of the water in East Matagorda Bay is apparently lower than that of Matagorda Bay. This difference is maintained because most of the discharge of the Colorado River is into East Matagorda Bay, and because the tidal inlet of East Matagorda Bay is much smaller and shallower than those of Matagorda Bay, which are larger and apparently more stable (Pass Cavallo, an inlet to Matagorda Bay to the southwest, is not shown on the maps accompanying this report).

The distribution of frequency facies of the five species so analyzed, variations in population density, and variations in the complexity of the foraminiferal

Table 3

Distribution of foraminifera and sediment-size data of surface-sediment samples from East Matagorda Bay

Grain size given in millimeters. Species recorded as per cent of total population.

AREA	EAST MATAGORDA BAY																																	E.M.B. DELTA EDGE							
SAMPLE NUMBER	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1000	1170	1172	1179	1180	1183	1186	
MEDIAN GRAIN SIZE	.013							.031			.018	.020	.027	.105	.088	.106	.106	.098			.037		.044	.043																	
SORTING COEFFICIENT	1.19							1.29			1.37	1.18	1.28	1.18	1.18	1.10	1.10	1.29			1.15		1.15	1.14																	
STANDARD DEVIATION	1.63							1.84			2.81	0.65	1.31	0.86	0.78	0.51	0.41	1.30			0.96		0.98	0.80																	
DEPTH OF WATER	2.0	5.5	6.0	6.0	5.0	5.5	5.5	3.0	5.5	5.5	5.0	5.5	5.0	5.0	3.5	4.5	5.0	6.0	5.0	5.0	5.0	6.0	5.0	5.5	5.0	4.5	5.5	5.0	6.5	6.5	6.0	4.5	2.0	2.5	1.0	2.0	2.5	0.3	1.2	1.5	2.0
TOTAL POPULATION	224	44	318					405	20	606	780	440	827	1165	726	830	798	181		715		898		483					2182							606	306	281	1483		
Ammobaculites arenario																													.5												
A. dilatatus					—							.2								.1						—		—					—			.3			.5	—	
A. salsus	.9	5.6	1.9							2.0			1.3	.5	.3	.2	.4	3.9		.5		2.8	—	2.6	—				6.5	—	—	—	—	—		2	.7		1.9	—	—
Haynesina stratfordi	.5								.5		.2	.3					.2					.1								—								.3	.1			
Cribroelphidium discoidale									1.5		.2	1.5	1.4	1.1	2.0	2.7	2.1	3.4		—	.1		1.0	1.9					.9	—					—	.6			.2	—	—
C. kugleri																													.5	—	—	—									
C. vadescens			.3	—	—		—	2.5		.3	.5								.6	.7		.1	—		—				2.1		—	—		—	1.7	4.3		4.1	—	—
Discorinopsis aguayoi																																							.2		
Elphidium advenum											.1			.3		.6	.1	—																—							
E. delicatulum	1.4				—			1.0		.3	.3				.6		.1			.1		.7						.8	—					—	—	.6	2.7	1.1	1.6	—	—
E. cf. fimbriatulum														.1																											
E. incertum mexicanum				—		—		2.2	5.0		.5	1.1	1.0	.9	2.2	.5	1.0		—	.4		2.0		.5	—	—			.4			—	—		—	.9	2.3	.6	.5	—	—
E. galvestonense	1.4			—		—		2.4	5.0	3.5	11.4	7.5	4.2	2.5	2.5	2.5	5.1	2.4	6.1		.5	—	2.2	—	2.2	—	—			1.3	—	—	—	—	—	—	4.0	2.0	.5	1.4	—	—
E. gunteri	30.7	41.5	41.2	—	—	—	—	22.2	60.0	36.4	32.9	24.3	23.2	19.9	23.9	22.5	23.3	9.9	—	24.4	—	23.5	—	26.5	—	—	—	—	21.9	—	—	—	—	—	—	21.0	19.2	9.1	21.5	—	—
E. matagordanum		1.1	.6	—				2.5		.7	.5	.5		.6		.5	.5			2.1		4.0	—	2.5	—				.1						—					—	
E. oceanicum																																									—	
E. poeyanum		1.1	.9			—		.7		.5	.1	.5	.4		.6		.9			.1		.1		1.0										—		.3		2.0	1.5	—	—
E. tumidum	1.5																												.1			—			—					—	
Flintina sp.																													.1	—											
Globigerina bulloides																.4								.2												.2	.7		.2		
Globigerinella aequilateralis																																				.1					
Guttulina australis											.1				.1	.4																									
Lenticulina cf. articulata																																										
Massilina peruviana														.1															.1	—		—						.1	—	
M. protea			.3					.3			.1			.1	.1							.1												—	—						
Miliammina fusca	.9																							.2												.2			.1		
Nonion germanicum														.3		.2				.1		.4		.2												.1			.2	—	—
N. cf. granosum	.5	2.3																											.5							.2		2.2	1.0		
N. pauciloculum					—							.7				.2				.1														—		.3					
Palmerinella palmerae	.9		.3					.5		.3				.1		.2	.3		—	.3		.4		1.2					.1				—			1.5	2.7	82.0	4.0	—	
Quinqueloculina sp.																													.1												
Q. cf. bicostata																													.1												
Q. candeiana										.2	.3	.9	1.1	.3	.1		.3					.1							.2	—					—	.2		.3	.4	—	—
Q. costata								.3				.3																										.3			—
Q. cultrata																																								.1		—
Q. durrandii																																					.3					
Q. lamarckiana								.3				.2	.2				.1													—											
Q. poeyana		1.1	.3	—				.5		.2			.4				.3																		—	—	.3			.3		
Q. polygona																													.1		—								.1		
Q. rhodiensis	.5							.3		.2	.1	.2		.1		1.1																			—	.3			.2		—
Q. sawanensis													.4	.2															.1	—					—				.1	—	
Q. seminulum		1.1		—				1.2		.7	1.0	1.1	.5	1.1	.4	.4	1.6		—	.1	—	.4		.2				—	.9	—		—		—	—	1.1	.7	.3	.3	—	
Q. seminulum jugosa											.1	.2	.2	.1															.4	—	—					.1	.3		.3		
Q. cf. subcarinata																														—							.3			.1		
Q. wiesneri										.2				.4																											
Recurvoides sp.																																										
Rotalbasella rotalbasensi															.1							.6		1.9					.3							.3					
Spirillina vivipara																																								.1		
Spiroloculina manifesta					—	—		.3			.1	.5																		—							.7		.2	—	—
Strebbus beccarii & vars.	66	44.	51.9	—	—	—	—	51.	30.	46.8	60.	57	63.6	68.9	57.	64.2	58.1	74.1	—	58.1	—	56.	—	36.	—	—		—	67.9	—	—	—	—			65.	66.	21.5	80.8	—	—
S. pauciloculata	4.6	2.3	.3	—			—	2.2		5.1		3.4	1.9	2.4	1.7	.6	7.4	5.5	—	5.1	—	5.2	—	10.3	—	—		—	5.2	—	—	—	—			.2	5.6	4.2	7.5	—	
Textularia aura																																								.2		
Triloculina sidebottomi																																								.2		
Trochammina inflata																																				.2		.3			

faunas within the area studied, when considered in relation to the variations in ecologic factors, convincingly indicate that the distribution of the foraminifera within the area is the result of a complex interaction of several ecologic factors and not the result of variations of a single factor. The more important ecologic factors determining the distribution of foraminifera as described for the area probably are salinity, organic content, extent and nature of water currents, turbulence, and biologic competition, with salinity variation the principal factor. Ecologic factors which do not appear to be important in determining the distribution of the foraminiferal facies within the area are temperature, depth of water, and turbidity.

Statistical comparative methods are apparently applicable in studies of this type, since it was possible

TABLE 4

DISTRIBUTION OF FORAMINIFERA IN SURFACE-SEDIMENT SAMPLES FROM THE COLORADO RIVER DELTA, MATAGORDA BAY EDGE OF DELTA, COLORADO RIVER CHANNEL, OYSTER LAKE, AND BRACKISH TO FRESH-WATER MARSH PONDS ON THE MAINLAND

Foraminifera recorded as per cent of total population.

AREA	COLORADO R. DELTA M.B.E.										COLORADO RIVER DELTA										C.R.C.		MARSH PONDS ON ML						OYSTER LAKE									
SAMPLE NUMBER	1150	1153	1155	1156	1157	1158	1159	1162	1163	1164	1005	1101	1174	1175	1176	1185	1183	1186	1187	1188	1149	1189	1146	1147	1148	1187	1188	1189	1190	1135	1138	1137	1136	1139	1140	1141	1142	1143	1144	1145
MEDIAN GRAIN SIZE																																								
SORTING COEFFICIENT																																								
STANDARD DEVIATION																																								
DEPTH OF WATER	3.0	2.0	2.0	0.5	2.0	1.0	1.5	1.5	1.0	1.0	3.0	0	0.3	2.0	1.0	0.5	0.2	1.0	1.0	1.0	1.0	2.5	1.0	0.1	4.0	1.0	2.0	0.4	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	1.5	1.0	1.5	0.5
TOTAL POPULATION		188		403		104	580	635		1215			1272	218	1776	2433		1647	77	963		1480	171	286	6832	337	447	116				988		423		2173				883
Ammobaculites arenaria							.5	.3	—	.9									.2							.9	3.1									.1	—			
A. dilatatus		1.6	—							1.8			1.1					.3		.2						.5				—	—		—	1.0		.1	—			
A. salsus	—	2.6	—		—		.7	1.3	—	15.0			4.4		6.3	.6		.8		1.4		8.0	1.2		.5	6.8	13.2	12.1		—	—	.4			—	.5	—		—	1.1
Arenoparrella mexicana										.1					2.8												1.8												
Cribroelphidium discoidale	—																																		.4				
C. cf. kaboconse																.1		.1																					
C. kugleri				2											.7				2.6											—									
C. vadescens	—	2.1			—	6.7	2.4	2.8	—	3.8			.2		2.0							.3		15.4				9.6											
Discorinopsis aguayoi							.3					—			.1				5.2																				
Elphidium advenum	—									.															.1														
E. delicatulum		3.2		4.5	—	1.9	2.4	.8	—	2.1	—		.3	.5	1.5	4.0		.8	2.6	.7		.8		2.6	.3		.5			—	—	.8		.7		.5	—		—	
E. cf. fimbriatulum																		.2																					
E. incertum mexicanum				.7	—	3.8	1.0	1.4	—	2.0			1.1	2.8	2.0	2.6		.4		1.1		.8			.5			6.9				.2		5	—	.1			—	.4
E. galvestonense	—	1.6	—	.5	—		1.0		—	.3			1.3		.4		—	.5				7.1	2.3	5.3	4.7			1.7		—	—	9.5	—	10.9	—	5.2	—	—	—	6.5
E. gunteri	—	29.7	—	7.4	—	5.8	11.2	7.4	—	14.7	—	—	9.4	11.9	15.2	3.9	—	5.8		9.2		7.9	9.9	8.3	5.2	3.0	3.8	11.2		—	—	7.7	—	9.5	—	3.8	—	—	—	10.3
E. matagordanum								.6	—	.9	—		.9		1.4	10.1			9.1			.8		1.1	.2	1.1	15.7											
E. oceanicum				1.2	—				—	5.8																	.3												
E. poeyanum	—	3.7		3.2	—	1.0	5.3		—	1.3				1.4	.9	.03		.4		1.4				1.8						—		.8		1.2		.7				
E. tumidum	—												.5		1.0											1								.2						
Flintina sp.							.2																																	
Globigerina bulloides		3.7								.3					.1					.4																				
Globigerinella aequilateralis																		.1																					
Globotruncana cf. linnaeana													.3			.03		.1	1.3																				
Lenticulina cf. articulata									—																															
Massilina peruviana	—															.03	—																						
M. protea		1.1							—				.2				—	.1							1											—			
Miliammina fusca				1.0									.3		.3									.2	.1		.5												
Nonion germanicum				.5			.8												5.9				1.6	.1															
N. cf. granosum	—	1.6		2.5			2.1	1.5	—	2.8				.5	.6	2.2		1.2	5.9	.5				.5								.2		.1					
N. pauciloculum																														—		.2								
Palmarinella palmerae			—	7.7	—	3.9	3	6.6	—	2.0	—		48.4	5.5	8.6	22.8	—	9.5	5.2	12.3				3.6	.2	12.8	1.6	32.8			—					.1	—			
Psammonyx sp.	—	.5						.2	—	.4																														
Quinqueloculina sp.	—																																						
Q. cf. bicostata															.1	.06									.1														
Q. candeiana	—						.3		—				.2		.6	.2		.1		.4																			
Q. costata	—	1.1							—						.03	.09																							
Q. lamarckiana	—	.5																.1																					
Q. poeyana									—		—		.2		.1	.1		.1																					
Q. polygona							.3		—							.09																								
Q. rhodiensis							.9	.2							.1	.1	—	.1																	.1			—	
Q. sawanensis													.2			.06																							
Q. seminulum	—	.8	—				.7		—	.4					.2	.1	—			.2																			
Q. seminulum jugosa										.1					.1	.06		.1																					
Recurvoides sp.															.4												1.6												
Reishauseria reishauseni		.5																																					
Spiroloculina manifesta							.7									.1		.1																					
Strebius beccarii & vars.	—	46	—	65.3	—	74.	65.2	74.	—	38.	—	—	29.1	72.	52.7	40.4	—	78.5	86.	71.4		74.3	83.	65.	89.1	74.6	66.4	26.7		—	—	79.7	—	76.7	—	67.9	—	—	—	78.4
S. pauciloculata	—	4.8	—	4.7	—	1.0	13.5	2.8	—	5.4	—	—	1.3	5.5	2.8	9.9	—	.9		1.1		.8				.6	2.2			—		.4				.4				
Textularia aura		.5								.1								.1				.3																	
T. earlandi									—	.7																													
Triloculina circularis																.03	—																					
T. sidebottomi										.1						.03																							
Trochammina inflata							.2						.3		1.0																								
T. macrescens															.1	.03											1.6												

to delineate the foraminiferal facies as described on the basis of the results of comparison of means tests of the mean frequencies of the five most abundant species in various geographic areas. Although the technique employed in paleoecologic work would of necessity be different, its utility seems quite certain. The basis of differentiation into facies is not dependent on species that occur at very low frequencies and consequently are easily missed in the small samples which must be worked with in some paleoecologic work. In addition, this technique of faunal analysis allows more objective and consistent inter-

TABLE 5

TABLE OF STUDENT "t" TEST PROBABILITIES THAT THE MEAN PERCENTAGES OF THE TOTAL POPULATION FOR A SPECIES IN ANY TWO AREAS WERE DERIVED FROM RANDOM SAMPLES OF A NORMALLY DISTRIBUTED HOMOGENEOUS POPULATION

PROBABILITY VALUES FOR:	Gulf littoral and Matagorda beach	Matagorda peninsula marsh	East Matagorda "fore" bay	East Matagorda "back" bay	East Matagorda bay inlet	Matagorda "fore" bay	Matagorda "back" bay	Matagorda bay–delta edge	East Matagorda bay–delta edge	Colorado river delta	Mainland marsh ponds	Oyster Lake
.000 *ELPHIDIUM GALVESTONENSE*												
.000 *ELPHIDIUM GUNTERI*												
.000 *PALMERINELLA PALMERAE*												
.000 *STREBLUS PAUCILOCULATA*												
.000 *S. BECCARII* & VARIANTS												
LEGEND												
AREAS COMPARED / NUMBER OF SAMPLES N	19	4	9	8	5	12	11	8	4	7	8	4
MEAN PERCENT $\bar{X}$	0.237	1.575	0.151	0.341	0.984	0.219	0.108	3.598	17.535	16.027	8.495	0.025
	0.119	4.780	2.770	5.749	1.572	2.455	15.618	5.307	4.625	3.060	0.472	0.205
	56.19	39.36	58.72	53.67	62.57	42.24	17.73	58.35	47.75	58.506	67.822	80.108
Σx^2	2.212	26.025	0.466	1.926	9.135	1.586	0.778	123.703	3875.197	3235.15	1252.65	0.008
	1.739	238.967	109.655	423.813	34.169	135.996	4177.390	260.971	110.809	140.206	5.366	0.336
	61743.9	7759.1	31344.8	24052.9	19762.2	1775.7	3873.7	21610.6	10130.8	25979.4	30029.1	25758.3
Gulf littoral and Matagorda beach — 19 / 1.159 / 36.621		.16	<.0001	.11	.072	<.0001	.16	.03	.011	.00055	.011	<.0001
19 / 14.044 / 4094.6		.39	<.0001	<.0001	.07	<.0001	<.0001	.44	.37	<.0001	<.0001	.031
Matagorda peninsula marsh — 4 / 0.678 / 2.517	.0027		.0009	.12	.0019	.00032	.32	.60	.001	.025	.0018	<.0001
4 / 15.893 / 1175.6	.0006		.0015	.033	.22	<.0001	<.0001	.158	.88	.0001	.00023	.006
East Matagorda "fore" bay — 9 / 5.400 / 348.793	.14	.009		<.0001	.001	.32	<.0001	<.0001	.016	<.0001	.0006	.07
9 / 25.060 / 5854.7	<.0001	.22		.0015	.058	<.0001	<.0001	<.0001	.003	<.0001	<.0001	<.0001
East Matagorda "back" bay — 8 / 1.706 / 50.249	.21	.021	<.0001		.84	<.0001	.90	.0038	.37	<.0001	.17	<.0001
8 / 28.719 / 7334.9	<.0001	.62	<.0001		.015	.21	<.0001	<.0001	.0045	<.0001	<.0001	.0003
East Matagorda bay inlet — 5 / 1.816 / 23.653	.0006	.158	.0007	.007		.00035	.82	<.0001	.155	<.0001	.175	<.0001
5 / 19.360 / 1954.6	.0012	.021	.10	.0032		.0016	<.0001	.0009	.28	.0006	<.0001	.0005
Matagorda "fore" bay — 12 / 5.926 / 519.643	.699	.049	.135	.065	.0018		<.0001	<.0001	.0055	<.0001	.00025	.12
12 / 30.236 / 11183.2	<.0001	.315	.20	.00018	.29		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Matagorda "back" bay — 11 / 1.657 / 101.081	.016	.0052	.20	.00073	.00053	<.0001		.10	.51	.012	.35	<.0001
11 / 43.865 / 22404.3	<.0001	.017	<.0001	<.0001	.0013	<.0001		<.0001	<.0001	<.0001	<.0001	<.0001
Matagorda bay-delta edge — 6 / 0.577 / 3.980	<.0001	.03	<.0001	<.0001	<.0001	<.0001	<.0001		.0035	<.0001	<.0001	<.0001
6 / 12.548 / 1311.68	<.0001	.73	.0005	.64	.00026	.0057	.0022		.135	.0013	.00017	.14
East Matagorda bay-delta edge — 4 / 2.303 / 27.709	.0012	.022	.0115	.013	.007	.0078	.009	.0305		.00018	.97	<.0001
4 / 16.180 / 1279.9	<.0001	.91	.066	.460	.0011	.052	.022	.54		.004	.00047	.0085
Colorado river delta — 7 / 0.290 / 1.694	<.0001	.0007	<.0001	<.0001	.00035	<.0001	<.0001	<.0001	.83		<.0001	<.0001
7 / 7.926 / 596.05	<.0001	.32	.60	.0004	.072	.41	<.0001	.0034	.18		<.0001	.4
Mainland marsh ponds — 8 / 2.328 / 57.377	.0004	.043	.0007	.001	.002	.001	.0009	.0009	.17	.0058		.0059
8 / 6.223 / 292.8	.035	.0087	.00017	<.0001	.006	.004	<.0001	<.0001	<.0001	<.0001		.034
Oyster Lake — 4 / 7.763 / 257.213	.055	.009	.049	.018	.001	.10	.35	.0008	.015	.004	.02	
4 / 9.318 / 429.6	.50	.01	.0025	.0028	.027	.02	<.0001	.0008	<.0001	<.0001	.23	
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	.00032	<.0001	.002	.044	

pretation of the variations in faunal content.

The close agreement of the foraminiferal facies with the geographic and oceanographic features of the area indicates possible successful use of fossil foraminiferal facies analysis in the reconstruction of the shore and near-shore paleogeography and paleoceanography of areas of marine sedimentation during the geologic past, particularly the Tertiary. This concept has recently been clearly expressed by Phleger (1954, pp. 610–611), and the results of the present study appear to offer supporting evidence for his general principles.

SYSTEMATICS

Order FORAMINIFERA

Family AMMODISCIDAE

Genus PSAMMONYX Doderlein, 1892

Psammonyx sp.

Psammonyx DODERLEIN, 1892, Deutsch. Zool. Ges., Verh., vol. 2, p. 145.

Family LITUOLIDAE

Subfamily HAPLOPHRAGMIINAE

Genus AMMOASTUTA Cushman and Bronnimann, 1948

Ammoastuta inepta (Cushman and McCulloch)

Ammobaculites ineptus CUSHMAN AND MCCULLOCH, 1939, Southern California, Univ., Publ., Allan Hancock Pacific Exped., vol. 6, no. 1, p. 89, pl. 7, fig. 6.

Genus AMMOBACULITES Cushman, 1910

Ammobaculites arenarius Natland
Plate 1, figure 1

Ammobaculites arenaria NATLAND, 1938, California, Univ., Scripps Inst. Oceanogr., Bull., Tech. Ser., vol. 4, no. 5, p. 139, pl. 3, figs. 7–8.

Ammobaculites dilatatus Cushman and Bronnimann
Plate 1, figures 2–3

Ammobaculites dilatatus CUSHMAN AND BRONNIMANN, 1948, Cushman Lab. Foram. Res., Contr., vol. 24, pt. 2, p. 39, pl. 7, figs. 10–11.

Ammobaculites salsus Cushman and Bronnimann
Plate 1, figures 4–5

Ammobaculites salsus CUSHMAN AND BRONNIMANN, 1948, Cushman Lab. Foram. Res., Contr., vol. 24, pt. 1, p. 16, pl. 3, figs. 7–9.

Genus RECURVOIDES Earland, 1934

Recurvoides sp.
Plate 1, figures 6–7

Recurvoides EARLAND, 1934, Discovery Repts., vol. 10, p. 90.

Family TEXTULARIIDAE

Subfamily TEXTULARIINAE

Genus TEXTULARIA Defrance, 1824

Textularia agglutinans d'Orbigny

Textularia agglutinans D'ORBIGNY, 1839, in: DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, Foram., p. 144, pl. 1, figs. 17–18, 32–34.

Textularia aura Lalicker and McCulloch
Plate 1, figures 8–9

Textularia aura LALICKER AND MCCULLOCH, 1940, Southern California, Univ., Publ., Allan Hancock Pacific Exped., vol. 6, no. 2, p. 119, pl. 13, fig. 5a–c.

Textularia conica d'Orbigny

Textularia conica D'ORBIGNY, 1839, in: DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, Foram., p. 143, pl. 1, figs. 19–20.

Textularia earlandi Parker

Textularia earlandi PARKER, 1952, Harvard Coll., Mus. Comp. Zoöl., Bull., vol. 100, no. 2, p. 106.

Textularia cf. **seranensis** Valk

Textularia seranensis VALK, 1945, in: RUTTEN AND HOTZ, Geol., Petrogr. and Pal. Results Expl. Island Ceram, ser. 3, no. 1, p. 20, pl. 2, figs. 5–6.

Family VERNEUILINIDAE

Genus GAUDRYINA d'Orbigny, 1839

Gaudryina exilis Cushman and Bronnimann

Gaudryina exilis CUSHMAN AND BRONNIMANN, 1948, Cushman Lab. Foram. Res., Contr., vol. 24, pt. 2, p. 40, pl. 7, figs. 15–16.

Family SILICINIDAE

Subfamily RZEHAKININAE

Genus MILIAMMINA Heron-Allen and Earland, 1930

Miliammina fusca (H. B. Brady)
Plate 1, figures 10–11

Quinqueloculina fusca H. B. BRADY, 1870, Ann. Mag. Nat. Hist., ser. 4, vol. 6, p. 286, pl. 11, figs. 2a–c, 3.

Family MILIOLIDAE

Genus FLINTINA Cushman, 1921

Flintina sp.

Flintina CUSHMAN, 1921, U. S. Nat. Mus., Bull. 100, vol. 4, p. 465.

Genus MASSILINA Schlumberger, 1893

Massilina peruviana (d'Orbigny)
Plate 1, figures 12–13, 18

Quinqueloculina peruviana D'ORBIGNY, 1839, Voy. Amér. Mérid., vol. 5, pt. 5, p. 73, pl. 4, figs. 1–3.

Massilina protea Parker
Plate 1, figures 14–16

Massilina protea PARKER, 1953, in: PARKER, PHLEGER, AND PEIRSON, Cushman Found. Foram. Res., Spec. Publ. no. 2, p. 10, pl. 2, figs. 1–4, text-fig. 2.

Genus QUINQUELOCULINA d'Orbigny, 1826

Quinqueloculina cf. **bicostata** d'Orbigny

Quinqueloculina bicostata d'ORBIGNY, 1839, in: DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, Foram., p. 195, pl. 12, figs. 8–10.

Quinqueloculina candeiana d'Orbigny
Plate 1, figures 17, 19

Quinqueloculina candeiana d'ORBIGNY, 1839, in: DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, Foram., p. 199, pl. 12, figs. 24–26.

Quinqueloculina costata d'Orbigny
Plate 1, figures 20–22

Quinqueloculina costata d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 135, no. 3 (*nomen nudum*). – TERQUEM, 1878, Soc. Géol. France, Mém., ser. 3, vol. 1, p. 63, pl. 6 (11), figs. 4–5.

Quinqueloculina cultrata (H. B. Brady)
Plate 1, figures 23–25

Miliolina cultrata H. B. BRADY, 1881, Quart. Jour. Micr. Sci., vol. 21, p. 45; 1884, Rept. Voy. Challenger, Zool., vol. 9, p. 161, pl. 5, figs. 1–2.

Quinqueloculina durrandii (Millett)

Miliolina durrandii MILLETT, 1898, Roy. Micr. Soc., Jour., p. 268, pl. 6, figs. 7–10.

Quinqueloculina funafutiensis (Chapman)
Plate 1, figures 26–27

Miliolina funafutiensis CHAPMAN, 1902, Linn. Soc. London, Jour., Zool., vol. 28, p. 178, pl. 19, fig. 6.

Quinqueloculina lamarckiana d'Orbigny
Plate 1, figures 28–30

Quinqueloculina lamarckiana d'ORBIGNY, 1839, in: DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, Foram., p. 189, pl. 11, figs. 14–15.

Quinqueloculina poeyana d'Orbigny
Plate 1, figures 31–33

Quinqueloculina poeyana d'ORBIGNY, 1839, in: DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, Foram., p. 191, pl. 11, figs. 25–27.

Quinqueloculina polygona d'Orbigny
Plate 1, figures 34–35

Quinqueloculina polygona d'ORBIGNY, 1839, in: DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, Foram., p. 198, pl. 12, figs. 21–23.

Quinqueloculina rhodiensis Parker
Plate 1, figures 36–38

Quinqueloculina rhodiensis PARKER, 1953, in: PARKER, PHLEGER, AND PEIRSON, Cushman Found. Foram. Res., Spec. Publ. no. 2, p. 12, pl. 2, figs. 15–17.

Quinqueloculina sawanensis Asano
Plate 2, figures 1–3

Quinqueloculina sawanensis ASANO, 1951, in: STACH (ed.), Ill. Cat. Japanese Tertiary Foram., pt. 6, p. 6, text-figs. 40–42.

Quinqueloculina seminulum (Linné)
Plate 2, figures 4–5, 9

Serpula seminulum LINNÉ, 1758, Syst. Nat., ed. 10, p. 786.

Quinqueloculina seminulum jugosa Cushman
Plate 2, figures 6–8

Quinqueloculina seminulum (Linné) var. *jugosa* CUSHMAN, 1944, Cushman Lab. Foram. Res., Spec. Publ. no. 12, p. 13, pl. 2, fig. 15.

Quinqueloculina cf. **subcarinata** d'Orbigny

Quinqueloculina subcarinata d'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 135, pl. 2, fig. 4a–c. – TERQUEM, 1878, Soc. Géol. France, Mém., ser. 3, vol. 1, p. 64, pl. 6, fig. 10a–c.

Quinqueloculina wiesneri Parr

Quinqueloculina anguina Terquem var. *wiesneri* PARR, 1950, B.A.N.Z. Antarctic Research Exped. 1929–31, Repts., ser. B, vol. 5, pt. 6, p. 290, pl. 6, figs. 9–10.

Genus SPIROLOCULINA d'Orbigny, 1826

Spiroloculina manifesta Cushman and Todd
Plate 2, figures 10–12

Spiroloculina manifesta CUSHMAN AND TODD, 1944, Cushman Lab. Foram. Res., Spec. Publ. no. 11, p. 62, pl. 8, figs. 26–28.

Genus TRILOCULINA d'Orbigny, 1826

Triloculina circularis Bornemann

Triloculina circularis BORNEMANN, 1855, Deutsch. Geol. Ges., Zeitschr., vol. 7, p. 349.

Triloculina sidebottomi (Martinotti)

Sigmoilina sidebottomi MARTINOTTI, 1920, Soc. Ital. Sci. Nat., Atti, vol. 59, p. 280, pl. 2, fig. 29, text-figs. 59–61.

Family TROCHAMMINIDAE

Subfamily TROCHAMMININAE

Genus TROCHAMMINA Parker and Jones, 1859

Trochammina inflata (Montagu)
Plate 2, figures 13–15

Nautilus inflatus MONTAGU, 1808, Test. Brit., Suppl., p. 81, pl. 18, fig. 13.

Trochammina macrescens H. B. Brady

Trochammina inflata (Montagu) var. *macrescens* H. B. BRADY, 1870, Ann. Mag. Nat. Hist., ser. 4, vol. 6, p. 51, pl. 11, fig. 5a–c.

Family LAGENIDAE

Subfamily NODOSARIINAE

Genus LENTICULINA Lamarck, 1804

Lenticulina cf. **articulata** (Reuss)

Robulina articulata REUSS, 1863, K. Akad. Wiss. Wien, Sitzber., vol. 48, p. 53, pl. 5, fig. 62.

Family POLYMORPHINIDAE

Subfamily POLYMORPHININAE

Genus GUTTULINA d'Orbigny, 1839

Guttulina australis (d'Orbigny)
Plate 2, figures 16–17

Globulina australis D'ORBIGNY, 1839, Voy. Amér. Mérid., vol. 5, pt. 5, p. 60, pl. 1, figs. 1–4.

Family NONIONIDAE

Genus CRIBROELPHIDIUM Cushman and Bronnimann, 1948

Cribroelphidium discoidale (d'Orbigny)
Plate 2, figures 18–20

Polystomella discoidalis D'ORBIGNY, 1839, in: DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, Foram., p. 56, pl. 6, figs. 23–24.

Cribroelphidium cf. **koeboeensis** (LeRoy)
Plate 2, figures 21–24

Elphidium koeboeense LEROY, 1939, Natuurk. Tijdschr. Nederl. Indië, vol. 99, pt. 6, p. 240, pl. 9, figs. 6–7.

Cribroelphidium kugleri Cushman and Bronnimann
Plate 2, figures 25–27

Cribroelphidium kugleri CUSHMAN AND BRONNIMANN, 1948, Cushman Lab. Foram. Res., Contr., vol. 24, p. 18, pl. 4, fig. 4a–b.

Cribroelphidium vadescens Cushman and Bronnimann
Plate 2, figures 28–29

Cribroelphidium vadescens CUSHMAN AND BRONNIMANN, 1948, Cushman Lab. Foram. Res., Contr., vol. 24, p. 18, pl. 4, fig. 5a–b.

Genus ELPHIDIUM Montfort, 1808

Elphidium advenum (Cushman)
Plate 2, figures 30–31

Polystomella advena CUSHMAN, 1922, Carnegie Inst. Washington, Publ. no. 311, p. 56, pl. 9, figs. 11–12.

Elphidium delicatulum Bermudez
Plate 2, figures 32–35

Elphidium delicatulum BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. no. 25, p. 168, pl. 11, figs. 22–23.

Elphidium cf. **fimbriatulum** (Cushman)
Plate 2, figure 36

Polystomella fimbriatula CUSHMAN, 1918, U. S. Geol. Survey, Bull. 676, p. 20, pl. 8, fig. 5a–b.

Elphidium galvestonense Kornfeld
Plate 2, figures 37–40

Elphidium gunteri Cole var. *galvestonensis* KORNFELD, 1931 (part), Stanford Univ., Dept. Geol., Contr., vol. 1, no. 3, p. 87, pl. 15, fig. 1a–b (not figs. 2a–b, 3a–b).

Elphidium gunteri Cole
Plate 3, figures 1–4

Elphidium gunteri COLE, 1931, Florida, State Geol. Survey, Bull. no. 6, p. 34, pl. 4, figs. 9–10.

Elphidium incertum mexicanum Kornfeld
Plate 3, figures 5–6

Elphidium incertum (Williamson) var. *mexicanum* KORNFELD, 1931, Stanford Univ., Dept. Geol., Contr., vol. 1, no. 3, p. 89, pl. 16, figs. 1–2.

Elphidium matagordanum (Kornfeld)
Plate 3, figures 7–8

Nonion depressula (Walker and Jacob) var. *matagordana* KORNFELD, 1931, Stanford Univ., Dept. Geol., Contr., vol. 1, no. 3, p. 87, pl. 13, fig. 2a–b.

Elphidium oceanicum Cushman
Plate 3, figures 9–12

Elphidium oceanicum CUSHMAN, 1933, U. S. Nat. Mus., Bull. 161, p. 52, pl. 12, fig. 7a–b.

Elphidium poeyanum (d'Orbigny)
Plate 3, figures 13–14

Polystomella poeyana D'ORBIGNY, 1839, in: DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, Foram., p. 55, pl. 6, figs. 25–26.

Elphidium tumidum Natland
Plate 3, figures 15–16

Elphidium tumidum NATLAND, 1938, California, Univ., Scripps Inst. Oceanogr., Bull., Tech. Ser., vol. 4, no. 5, p. 144, pl. 5, figs. 5–6.

Genus NONION Montfort, 1808

Nonion germanicum (Ehrenberg)
Plate 3, figures 17–18

Nonionina germanica EHRENBERG, 1840, K. Preuß. Akad. Wiss. Berlin, Ber., p. 23; 1841, K. Akad. Wiss. Berlin, Physik.-Math. Kl., Abh., Jahrg. 1839, p. 133, pl. 2, fig. 1a–g.

Nonion cf. **granosum** (d'Orbigny)
Plate 3, figures 19–20

Nonionina granosa D'ORBIGNY, 1846, Foram. foss. Vienne, p. 110, pl. 5, figs. 19–20.

Nonion pauciloculum Cushman
Plate 3, figures 21–22

Nonion pauciloculum CUSHMAN, 1944, Cushman Lab. Foram. Res., Spec. Publ. no. 12, p. 24, pl. 3, fig. 25a–b.

Family BULIMINIDAE

Subfamily VIRGULININAE

Genus BOLIVINA d'Orbigny, 1839

Bolivina striatula Cushman

Bolivina striatula CUSHMAN, 1922, Carnegie Inst. Washington, Publ. no. 311, p. 27, pl. 3, fig. 10.

Family ROTALIIDAE

Subfamily SPIRILLININAE

Genus SPIRILLINA Ehrenberg, 1843

Spirillina vivipara Ehrenberg

Spirillina vivipara EHRENBERG, 1843, K. Akad. Wiss. Berlin, Physik. Abh., Jahrg. 1841, pt. 1, p. 422, pl. 3, sec. 7, fig. 41.

Subfamily DISCORBINAE

Genus LAMARCKINA Berthelin, 1881

Lamarckina atlantica Cushman

Lamarckina atlantica CUSHMAN, 1931, U. S. Nat. Mus., Bull. 104, pt. 8, p. 35, pl. 7, fig. 7a–c.

Subfamily ROTALIINAE

Genus ARENOPARRELLA Andersen, 1951

Arenoparrella mexicana (Kornfeld)
Plate 3, figures 23–25

Trochammina inflata (Montagu) var. *mexicana* KORNFELD, 1931, Stanford Univ., Dept. Geol., Contr., vol. 1, no. 3, p. 86, pl. 13, fig. 5a–c.

Genus EPONIDES Montfort, 1808

Eponides repandus (Fichtel and Moll)

Nautilus repandus FICHTEL AND MOLL, 1798, Test. Micr., p. 35, pl. 3, figs. a–d.

Eponides regularis Phleger and Parker

Eponides regularis PHLEGER AND PARKER, 1951, Geol. Soc. Amer., Mem. 46, pt. 2, p. 21, pl. 11, figs. 3a–b, 4a–c.

Genus ROLSHAUSENIA Bermudez, 1952

Rolshausenia rolshauseni (Cushman and Bermudez)
Plate 3, figures 26–28

Rotalia rolshauseni CUSHMAN AND BERMUDEZ, 1946, Cushman Lab. Foram. Res., Contr., vol. 22, pt. 4, p. 119, pl. 19, figs. 11–13.

Genus STREBLUS Fischer, 1817

Streblus beccarii (Linné) and variants
Plate 3, figures 29–31

Nautilus beccarii LINNÉ, 1758, Syst. Nat., ed. 10, p. 710.
Rotalia beccarii (Linné) of authors.

Streblus pauciloculatus (Phleger and Parker)
Plate 3, figures 32–35

"*Rotalia*" *pauciloculata* PHLEGER AND PARKER, 1951, Geol. Soc. Amer., Mem. 46, pt. 2, p. 25, pl. 12, figs. 8a–b, 9a–b.

Subfamily SIPHONININAE

Genus POROEPONIDES Cushman, 1944

Poroeponides lateralis (Terquem)
Plate 3, figures 36–38

Rosalina lateralis TERQUEM, 1878, Soc. Géol. France, Mém., ser. 3, vol. 1, no. 3, p. 25, pl. 2, fig. 11a–c.

Genus DISCORINOPSIS Cole, 1941

Discorinopsis aguayoi (Bermudez)

Discorbis aguayoi BERMUDEZ, 1935, Soc. Cubana Hist. Nat., Mem., vol. 9, no. 3, p. 204, pl. 15, figs. 10–14.

Family GLOBIGERINIDAE

Subfamily GLOBIGERININAE

Genus GLOBIGERINA d'Orbigny, 1826

Globigerina bulloides d'Orbigny

Globigerina bulloides D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 277, no. 1; modèles, no. 76 and no. 17 (young).

Genus GLOBIGERINELLA Cushman, 1927

Globigerinella aequilateralis (H. B. Brady)

Globigerina aequilateralis H. B. BRADY, 1879, Quart. Jour. Micr. Sci., new ser., vol. 19, p. 71.

Family GLOBOROTALIIDAE

Genus GLOBOTRUNCANA Cushman, 1927

Globotruncana cf. **linnaeana** (d'Orbigny)

Rosalina linnaeana D'ORBIGNY, 1839, Foram. Cuba, p. 106, pl. 5, figs. 10–12.

Family ANOMALINIDAE

Subfamily ANOMALININAE

Genus PALMERINELLA Bermudez, 1934

Palmerinella palmerae Bermudez
Plate 3, figures 39–40

Palmerinella palmerae BERMUDEZ, 1934, Soc. Cubana Hist. Nat., Mem., vol. 8, no. 2, p. 84, text-figs. 1–3.

Subfamily CIBICIDINAE

Genus HANZAWAIA Asano, 1944

Hanzawaia strattoni (Applin)
Plate 3, figures 41–43

Truncatulina americana Cushman var. *strattoni* APPLIN, 1925, in: APPLIN, ELLISOR, AND KNIKER, Amer. Assoc. Petr. Geol., Bull., vol. 9, no. 1, p. 99, pl. 3, fig. 3.

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1913 – *Ibid.; Part III – Lagenidae.* U. S. Nat. Mus., Bull., no. 71, pt. 3, pp. 1–125, pls. 1–47.
1914 – *Ibid.; Part IV – Chilostomellidae, Globigerinidae, Nummulitidae.* U. S. Nat. Mus., Bull., no. 71, pt. 4, pp. 1–46, pls. 1–19.
1915 – *Ibid.; Part V – Rotaliidae.* U. S. Nat. Mus., Bull., no. 71, pt. 5, pp. 1–87, pls. 1–31, text-figs. 1–62.
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PLATE 1

All illustrations are stereophotomicrographs and all are × 32 unless otherwise noted; only the right-hand member of each stereo-pair is numbered.

1 *Ammobaculites arenarius* Natland
Lateral view of specimen from sample 1032.

2–3 *Ammobaculites dilatatus* Cushman and Bronnimann
Lateral and apertural views of a specimen from sample 1150.

4–5 *Ammobaculites salsus* Cushman and Bronnimann
Lateral views of specimens from samples 1053 and 1153.

6–7 *Recurvoides* sp.
Lateral and peripheral views of specimen from sample 1176.

8–9 *Textularia aura* Lalicker and McCulloch
Lateral and side views of a specimen from sample 1195.

10–11 *Miliammina fusca* (H. B. Brady)
Lateral and apertural views of specimen from sample 1076.

12–13, 18 *Massilina peruviana* (d'Orbigny)
Lateral views and apertural view, × 15.5, of specimen from sample 1035.

14–16 *Massilina protea* Parker
Lateral views and apertural view of specimen from sample 1086.

17, 19 *Quinqueloculina candeiana* d'Orbigny
Apertural and lateral views of specimen from sample 1170.

20–22 *Quinqueloculina costata* d'Orbigny
Opposed lateral and apertural views of specimen from sample 1150.

23–25 *Quinqueloculina cultrata* (H. B. Brady)
Apertural and opposed lateral views of a specimen from sample 1086.

26–27 *Quinqueloculina funafutiensis* (Chapman)
Lateral and apertural views of specimen from sample 1182.

28–30 *Quinqueloculina lamarckiana* d'Orbigny
Lateral, apertural, and lateral views of specimen from sample 1073.

31–33 *Quinqueloculina poeyana* d'Orbigny
Opposed lateral and apertural views of specimen from sample 1107.

34–35 *Quinqueloculina polygona* d'Orbigny
Apertural and lateral views of specimen from sample 1185.

36–38 *Quinqueloculina rhodiensis* Parker
Opposed lateral and apertural views of specimen from sample 1195.

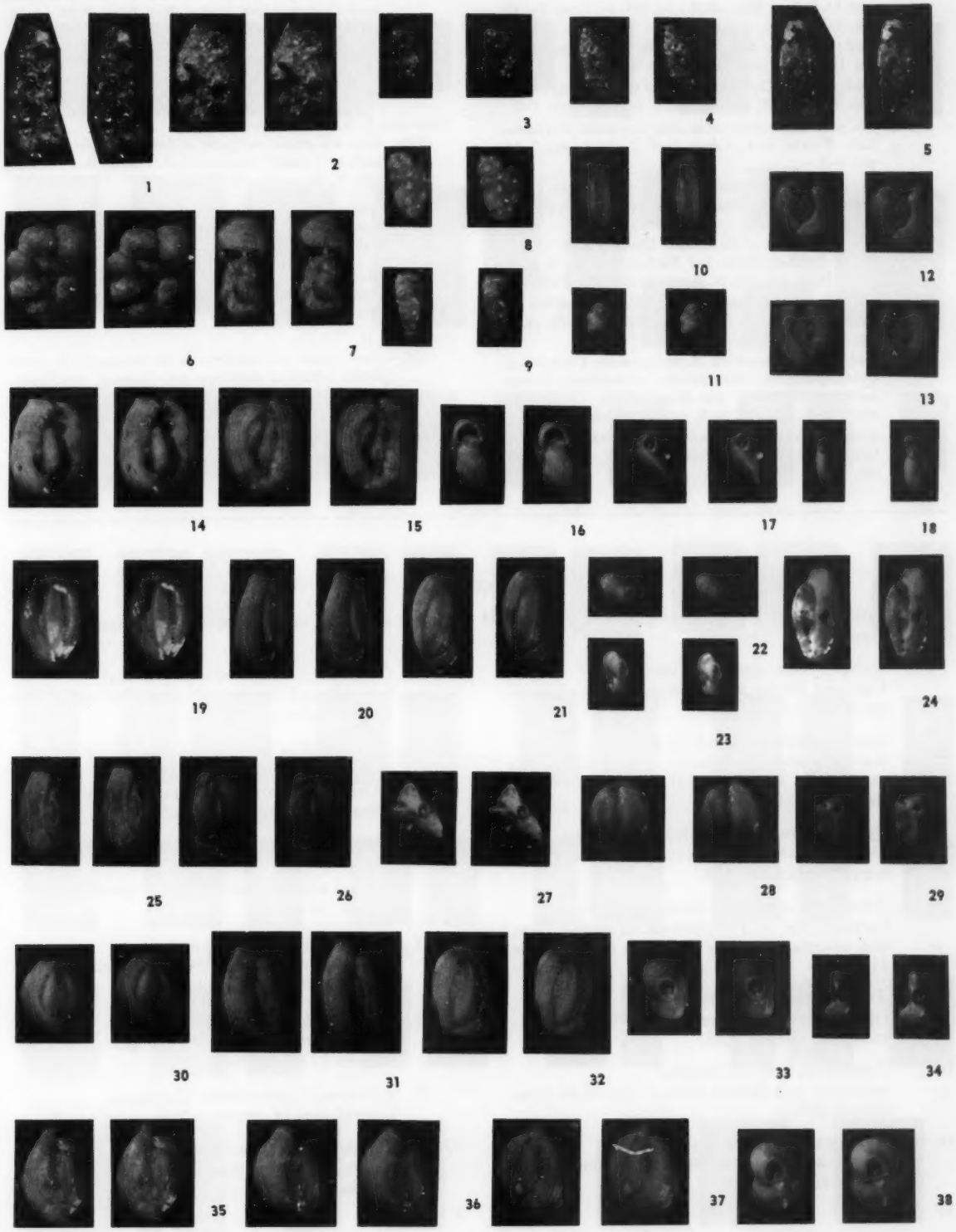
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PLATE 2

All illustrations are stereophotomicrographs and all are × 32 unless otherwise noted; only the right-hand member of each stereo-pair is numbered.

1–3 *Quinqueloculina sawanensis* Asano
Opposed lateral and apertural views of specimen from sample 1035.

4–5, 9 *Quinqueloculina seminulum* (Linné)
Lateral view of specimen from sample 1023 and lateral and apertural views of specimen from sample 1081.

6–8 *Quinqueloculina seminulum jugosa* Cushman
Opposed lateral and apertural views of specimen from sample 1174.

10–12 *Spiroloculina manifesta* Cushman and Todd
Lateral view, × 15.5, non-stereo lateral view, and apertural view of specimen from sample 1182.

13–15 *Trochammina inflata* (Montagu)
Opposed lateral and peripheral views of specimen from sample 1176.

16–17 *Guttulina australis* (d'Orbigny)
Apertural and lateral views of specimen from sample 1074.

18–20 *Cribroelphidium discoidale* (d'Orbigny)
Lateral and apertural views of specimens from sample 1079.

21–24 *Cribroelphidium* cf. *koeboeense* (LeRoy)
Lateral and apertural views of specimens from samples 1067 and 1058.

25–27 *Cribroelphidium kugleri* Cushman and Bronnimann
Lateral, apertural, and lateral views of specimens from samples 1035 and 1036.

28–29 *Cribroelphidium vadescens* Cushman and Bronnimann
Lateral and apertural views of specimen from sample 1001.

30–31 *Elphidium advenum* (Cushman)
Lateral and apertural views of specimen from sample 1040.

32–35 *Elphidium delicatulum* Bermudez
Lateral and apertural views of specimens from samples 1170 and 1067.

36 *Elphidium* cf. *fimbriatulum* (Cushman)
Lateral view of specimen from sample 1079.

37–40 *Elphidium galvestonense* Kornfeld
Lateral and peripheral views of specimens from sample 1150.

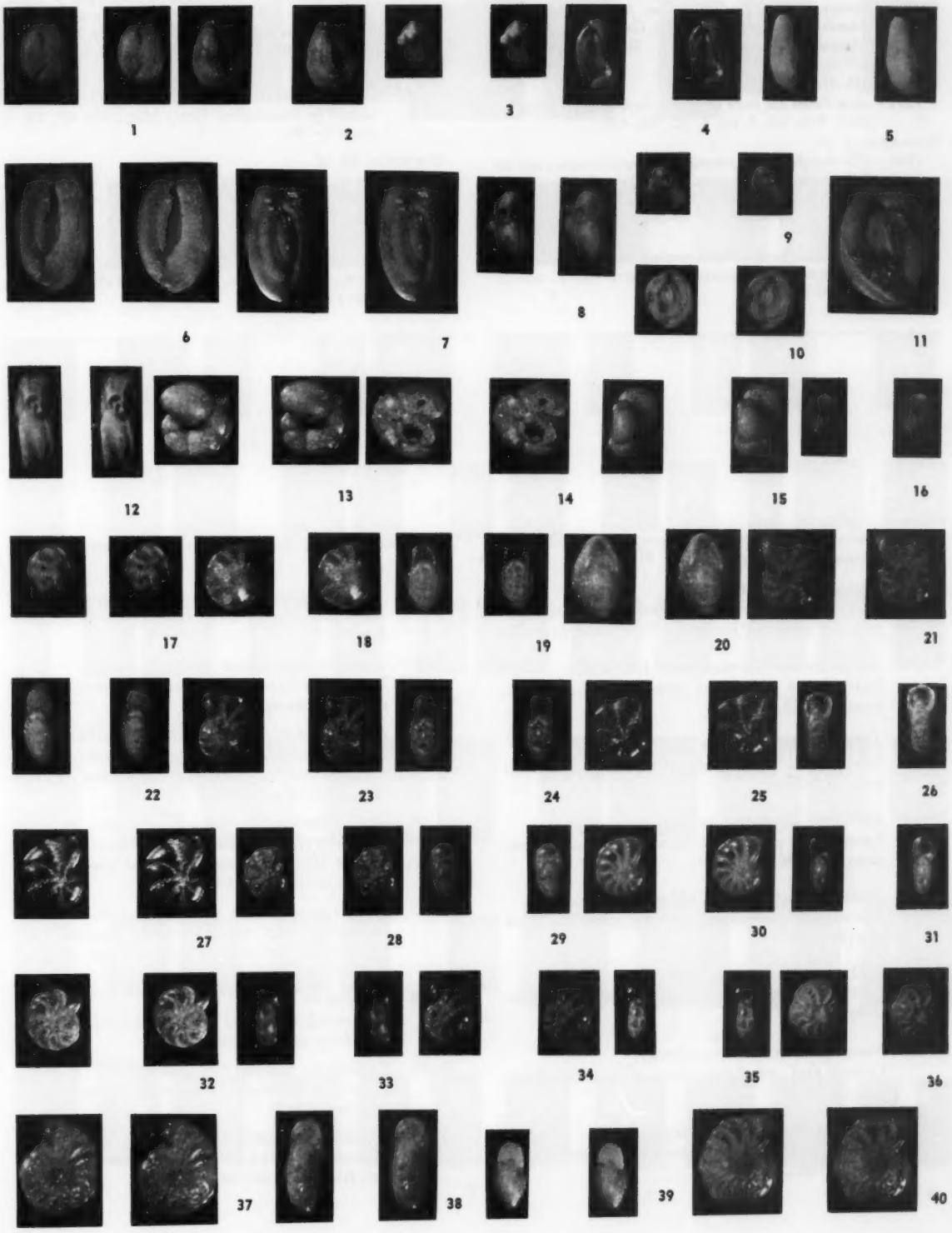
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PLATE 3

All illustrations are stereophotomicrographs and all are × 32 unless otherwise noted; only the right-hand member of each stereo-pair is numbered.

1–4 *Elphidium gunteri* Cole
Lateral, peripheral, non-stereo lateral, and peripheral views of specimens from sample 1150.

5–6 *Elphidium incertum mexicanum* Kornfeld
Lateral and peripheral views of specimen from sample 1028.

7–8 *Elphidium matagordanum* (Kornfeld)
Lateral and peripheral views of specimen from sample 1083.

9–12 *Elphidium oceanicum* Cushman
Lateral and peripheral views of specimens from samples 1070 and 1040.

13–14 *Elphidium poeyanum* (d'Orbigny)
Lateral and peripheral views of specimen from sample 1065.

15–16 *Elphidium tumidum* Natland
Lateral and peripheral views of specimen from sample 1004.

17–18 *Nonion germanicum* (Ehrenberg)
Lateral and peripheral views of specimen from sample 1017.

19–20 *Nonion* cf. *granosum* (d'Orbigny)
Lateral and peripheral views of specimen from sample 1065.

21–22 *Nonion pauciloculum* Cushman
Lateral and peripheral views of specimen from sample 1078.

23–25 *Arenoparrella mexicana* (Kornfeld)
Lateral, peripheral, and lateral views of specimen from sample 1176.

26–28 *Rolshausenia rolshauseni* (Cushman and Bermudez)
Lateral and apertural views of specimen from sample 1081. An opposed lateral view of specimen from sample 1089.

29–31 *Streblus beccarii* (Linné) and variants
Lateral and apertural views of specimen from sample 1059. An opposed lateral view of specimen from sample 1150.

32–35 *Streblus pauciloculatus* (Phleger and Parker)
Lateral view of specimen from sample 1069. Opposed lateral and peripheral views of specimen from sample 1163.

36–38 *Poroeponides lateralis* (Terquem)
Opposed lateral and peripheral views of specimen from sample 1105.

39–40 *Palmerinella palmerae* Bermudez
Lateral and apertural views of specimen from sample 1195.

41–43 *Hanzawaia strattoni* (Applin)
Opposed lateral and peripheral views of specimen from sample 1081.

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ABSTRACT: *Sclerites of alcyonarians are frequent in certain sediments. A new classification is tentatively proposed to facilitate their study and their use in stratigraphy and paleobiology.*

A classification of fossil alcyonarian sclerites

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INTRODUCTION

Alcyonarian sclerites, detached from the polyps of which they were once a part, are found in association with other microfossils in sedimentary rocks derived from marine sands. The study of these sclerites has been largely neglected until very recently. Nevertheless, they are actually of considerable stratigraphic and ecologic importance. The presence, especially in abundance, of alcyonarian sclerites in a rock gives highly valuable indications of the genesis and original facies of the rock. It was their very abundance in material from the Balcombian (Middle Miocene) of Australia that started me on my research.

Before my studies began, fossil alcyonarian sclerites were known only from Počta's (1885) illustration of *Nephthya cretacea* from the Upper Cretaceous of Bohemia, which was reproduced by Glaessner (1945). Cayeux (1935) also described limestones with alcyonarian spicules, but did not figure them. The latter author's data should be verified. At the time of his trip to Paris in July of 1955, Glaessner informed me that he had frequently seen sclerites in certain Tertiary localities in New Guinea, and that he also remembered seeing them in the Cretaceous of Bohemia, as well as in the Urals. I have already reported these unpublished observations (Deflandre-Rigaud, 1956). It is also quite possible that sclerites have been figured in unpublished reports or even, as accessory material, in papers on foraminifera, and that these publications have escaped the notice of bibliographers.

No valid conclusions can be drawn from the study of alcyonarian sclerites until the basic data have been gathered together and arranged in a practical manner. I have therefore attempted a classification based on the morphologic system proposed by Croneis, which I adopted in 1948 for the holothurians. This system could also have been used, I believe, by palynologists and by all paleobotanists. The terms "manipulus" (at the taxonomic level of the genus) and "centuria" (at the taxonomic level of the species) would be very appropriate for spores, pollen, and wood fragments, and for fossil tree trunks and roots known only in section. Unfortunately, it does not appear that any agreement has been reached on this point. For example, Frizzell and Exline (1955) treat fossil holothurian sclerites as genera and species, which is unacceptable to a biologist. It is possible, therefore, if desired, to validate as a genus the manipulus *Micralcyonarites* Deflandre-Rigaud, 1955, in which I included all the fossil alcyonarian sclerites found isolated in sedimentary rocks. Generally speaking, the forms of *Micralcyonarites* have a characteristic fibrous structure. This structure is, however, sometimes scarcely discernible, even in the sclerites of Recent gorgonians. Except in very rare cases, there is no central canal.

In living alcyonarians, different morphologic types of sclerites have been recognized for many years: capitate sclerites, fusiform sclerites, clavate sclerites, trap-shaped sclerites, and squamiform sclerites. In my work, I have differentiated species (or centuriae) of *Micralcyonarites* on the basis of the following characters: a) general form; b) form of the ornamentation, such as tubercles, spines, etc.; c) arrangement of the ornamentation; d) texture of the sclerites; e) dimensions. The appearance in polar-

ized light may also be characteristic. I have refrained from establishing centuriae (or species) to encompass types (such as the so-called trap-shaped forms) that I have not yet found in my material, even though they must be present in Tertiary and Mesozoic sediments. It would actually have been possible to establish a system of morphologic classification on the basis of all the types of sclerites known in the Recent alcyonarian fauna. I have rejected this working method because it would introduce too high a degree of abstraction into the subject; it is not a question of differentiating idealized types, but of differentiating tangible types represented by selected specimens. All the forms named here are preserved and catalogued on slides in the collections of the Micropaleontological Laboratory of the École Pratique des Hautes Études in Paris (E.P.H.E.).

It is well to note, in conclusion, that among the forms of *Micralcyonarites*, certain forms correspond to classic types that exist, with variations, in many Recent species. My material often contains a large number of individuals that are, if not identical, at least clearly related, and that belonged very probably to a single species. Others, on the contrary, may present a rather unusual form, justifying differentiation even though the specimen appears to represent a rare type at first sight. Thus, among the types that I have described, two or three may not be found again in the near future, but the majority will, within a short time, be found again and recognized by research workers who are interested in this new field.

SYSTEMATIC DESCRIPTIONS

Genus **Micralcyonarites** Deflandre-Rigaud, 1955

Micralcyonarites DEFLANDRE-RIGAUD, 1955, Acad. Sci., C. R., vol. 241, p. 1329; 1956, Ann. Pal., vol. 42, p. 10.

Description: Fossil calcareous alcyonarian sclerites, with generally fibrous microstructure, most often verrucose or spinose, rarely smooth, and variable in form: spindle, club, mallet, dumbbell, plate, etc.

Type: Micralcyonarites vulgaris Deflandre-Rigaud, 1955.

Micralcyonarites vulgaris Deflandre-Rigaud
Plate 1, figures 1, 6

Micralcyonarites vulgaris DEFLANDRE-RIGAUD, 1955, Acad. Sci., C. R., vol. 241, p. 1328, text-fig. 1; 1956, Ann. Pal., vol. 42, p. 10, pl. 1, figs. 1–6.

Description: Sclerites in the form of a regular spindle, elongate or very elongate, straight, arcuate, or more or less sigmoidally curved, ornamented with protuberances that are not crowded together, arranged with no apparent order, obtuse or more or less verrucose. Structure fibrous or highly fibrous, appearance hyaline or brownish. In polarized light, extinction is incomplete or highly incomplete, sometimes with the protuberances highly colored; in the oblique position, grayish white with highly colored margins.

Dimensions: Length of holotype 425μ; maximum width 70μ. Length of other specimens 186–371μ; width 42–74μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., nos. BX 9 (holotype), BX 10, and BX 14.

Remarks: In the memoir cited, for each fossil form I gave examples of Recent species possessing sclerites of comparable form.

Micralcyonarites robustus Deflandre-Rigaud
Plate 1, figure 3

Micralcyonarites robustus DEFLANDRE-RIGAUD, 1956, Ann. Pal., vol. 42, p. 11, pl. 1, figs. 7–10.

Description: Sclerites thick, the majority cylindrical, with extremities conical or divaricated, ornamented with very large protuberances that are obtuse or mamillate. Structure fibrous, appearance hyaline or brownish. In polarized light, extinction is highly incomplete; in the oblique position, the color is grayish white, with expansions more or less colored.

Dimensions: Length 220–232μ; maximum width 54–57μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., nos. BX 10 (holotype), and BX 9.

Micralcyonarites gallicus Deflandre-Rigaud
Plate 2, figure 1

Micralcyonarites gallicus DEFLANDRE-RIGAUD, 1955, Acad. Sci., C. R., vol. 241, p. 1328, text-fig. 16; 1956, Ann. Pal., vol. 42, p. 11, pl. 1, figs. 11–12.

Description: Sclerites fusiform, ornamented with protuberances that are thick and subcylindrical with obtuse extremities, oriented perpendicular to the axis of the sclerite, and of larger size in the median part. Structure usually granulose, apparently not fibrous (masked by fossilization?); in polarized light with bright colors.

Dimensions: Length 194μ; maximum width 48μ.

Occurrence: Holotype from the Middle Eocene, Lutetian, in limestone from Fleury-la-Rivière, Dept. Marne, France.

Depository: E.P.H.E. Micropal. Lab., no. BN 90 (holotype).

Micralcyonarites fusunculus Deflandre-Rigaud
Plate 1, figure 7

Micralcyonarites fusunculus DEFLANDRE-RIGAUD, 1955, Acad. Sci., C. R., vol. 241, p. 1328, text-fig. 3; 1956, Ann. Pal., vol. 42, p. 12, pl. 3, figs. 1–2.

Description: Sclerites in the form of a highly elongate regular spindle, slightly curved, ornamented with small protuberances that are widely spaced, the majority projecting very little. Structure distinctly fibrous, color light brownish. In polarized light, bright colors and incomplete extinction, with rather regularly distributed colored patches except for the axis, which remains dark.

Dimensions: Length 278μ; width 42μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., no. BX 6 (holotype).

Micralcyonarites fusticulus Deflandre-Rigaud
Plate 1, figure 8

Micralcyonarites fusticulus DEFLANDRE-RIGAUD, 1955, Acad. Sci., C. R., vol. 241, p. 1328, text-fig. 2; 1956, Ann. Pal., vol. 42, p. 12, pl. 3, figs. 3–4.

Description: Sclerites highly elongated, fragile and usually incomplete, subcylindrical with constricted extremities, ornamented with protuberances that are very irregularly arranged, generally not protruding much. Structure fibrous or very fibrous, color light brownish. In polarized light, colors bright in the oblique position; parallel to the axes of the nicols, extinction is always incomplete, with traces of colored areas remaining here and there throughout the sclerite.

Dimensions: Length 259–414μ; width 30–50μ. Since no specimen was absolutely complete, the lengths given must be considered minimal.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., nos. BX 14 (holotype), BX 6, and BX 7.

Micralcyonarites undatus Deflandre-Rigaud
Plate 1, figure 11

Micralcyonarites undatus DEFLANDRE-RIGAUD, 1956, Ann. Pal., vol. 42, p. 13, pl. 3, figs. 7–8.

Description: Sclerites cylindrical or tending toward fusiform, with extremities truncated or rounded, rarely conical. Ornamentation consisting of conical undulations, protruding very little, which resemble, in the optical median section, small waves with obtuse crests. Structure highly fibrous. In polarized light, extinction is incomplete, with slightly lighter areas remaining; in the oblique position showing dark areas.

Dimensions: Length of holotype 162μ; width 34μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., nos. BX 7 (holotype), BX 7, and BX 9.

Micralcyonarites perverrucosus Deflandre-Rigaud
Plate 1, figure 2

Micralcyonarites perverrucosus DEFLANDRE-RIGAUD, 1955, Acad. Sci., C. R., vol. 241, p. 1328, text-fig. 5; 1956, Ann. Pal., vol. 42, p. 13, pl. 2, figs. 3–4.

Description: Sclerites broadly fusiform, straight or twisted, ornamented with verrucose protuberances that are closely spaced and arranged without order. Structure fibrous, color slightly brownish; in polarized light, extinction is highly incomplete; in the oblique position, bright with a roseate center, margin grayish white and protuberances colored.

Dimensions: Length 251–255μ; maximum width 62–70μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., nos. BX 8 (holotype), BX 12, and BX 17.

Micralcyonarites cretaceus (Počta) Deflandre-Rigaud
Plate 2, figure 4

Nephthya cretacea POČTA, 1885, K. Akad. Wiss. Wien, Math.-Naturw. Cl., Sitzber., vol. 92, p. 10, pl. 1, fig. 7.
Micralcyonarites cretaceus (Počta). – DEFLANDRE-RIGAUD, 1955, Acad. Sci., C. R., vol. 241, p. 1329; 1956, Ann. Pal., vol. 42, p. 14, text-fig. 1.

Description: Sclerites in the form of an elongate double cone, tapering gradually toward the extremities, straight, slightly arcuate, or irregularly recurved, ornamented on the surface with numerous irregularly distributed protuberances, which are occasionally arranged in sinuous lines. Protuberances sometimes simple, more often divided at their extremities into a number of small knobs or warts. No axial canal.

Dimensions: Length 900–1600μ; width 200–280μ.

Occurrence: Upper Cretaceous, Teplitz beds, Kostitz near Laun, Bohemia, Czechoslovakia.

Micralcyonarites pedigerus Deflandre-Rigaud
Plate 1, figure 12

Micralcyonarites pedigerus DEFLANDRE-RIGAUD, 1955, Acad. Sci., C. R., vol. 241, p. 1328, text-fig. 12; 1956, Ann. Pal., vol. 42, p. 15, pl. 2, figs. 1–2; pl. 4, figs. 15–16.

Description: Sclerites subcylindrical, constricted very slightly at the extremities, ornamented with solid mamillated protuberances; many protuberances lying on the

same side of the sclerite are strongly developed. Structure fibrous or highly fibrous. In polarized light, extinction is incomplete parallel to the nicols; in the oblique position, colors more or less bright according to the texture.

Dimensions: Length of holotype 100μ; maximum width 46μ. Length of paratype 247μ; ; width 87μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., nos. BX 6 (holotype), and BX 14.

Micralcyonarites conjunctus Deflandre-Rigaud
Plate 1, figure 4

Micralcyonarites conjunctus DEFLANDRE-RIGAUD, 1956, Ann. Pal., vol. 42, p. 15, pl. 2, figs. 5–6.

Description: Sclerites elongate, slightly fusiform or subcylindrical, ornamented with protuberances, some of which are only slightly elevated and spaced rather wide apart, whereas others are highly elevated, closely spaced, and lying all on one side of the sclerite. Color light brown, structure slightly fibrous. In polarized light, in the oblique position, colors bright, especially in the large protuberances.

Dimensions: Length of holotype 232μ; maximum width 43μ. Length of paratype 194μ; width 39μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., no. BX 10 (holotype).

Micralcyonarites clava Deflandre-Rigaud
Plate 2, figure 2

Micralcyonarites clava DEFLANDRE-RIGAUD, 1955, Acad. Sci., C. R., vol. 241, p. 1328, text-fig. 7; 1956, Ann. Pal., vol. 42, p. 15, pl. 2, figs. 7–8.

Description: Sclerites in the form of a club, with protuberances that are simple or slightly verrucose, irregularly arranged or arranged in coronae. Structure highly fibrous. In polarized light, extinction is usually complete, except sometimes one or two protuberances that are differently oriented; in the oblique position, rosy white or with bright colors.

Dimensions: Length 140–250μ; maximum width about 50–70μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., no. BX 16.

Micralcyonarites alloiteaui Deflandre-Rigaud
Plate 1, figure 5

Micralcyonarites alloiteaui DEFLANDRE-RIGAUD, 1955, Acad. Sci., C. R., vol. 241, p. 1328, text-fig. 6; 1956, Ann. Pal., vol. 42, p. 16, pl. 2, figs. 9–10.

Description: Sclerites in the form of a club, highly enlarged at one end by a group of foliate expansions that are more or less divergent. Opposite end subcylindrical, ornamented with widely spaced protuberances that are obtuse or slightly verrucose. Structure slightly fibrous, appearance hyaline. In polarized light, extinction is complete parallel to the axes of the nicols; colors bright at about 45°.

Dimensions: Length 218μ; maximum width 77μ. Length of paratype 130μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., nos. BX 20 (holotype), BX 3, BX 8, BX 9, and BX 13.

Micralcyonarites scopula Deflandre-Rigaud
Plate 1, figure 9

Micralcyonarites scopula DEFLANDRE-RIGAUD, 1955, Acad. Sci., C. R., vol. 241, p. 1328, text-fig. 4; 1956, Ann. Pal., vol. 42, p. 16, pl. 3, figs. 5–6.

Description: Sclerites in the form of an elongated mallet, slightly thinner at one extremity, wider at the other, ornamented with irregular verrucose protuberances that are more developed toward the broad end, especially toward the extremity, where they become elongate and form a kind of lateral tuft. Structure fibrous, color straw-yellow or hyaline; in polarized light, colors bright and iridescent; extinction incomplete.

Dimensions: Length 371μ; maximum width 66μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., nos. BX 17 (holotype), BX 7, and BX 11.

Micralcyonarites corallioides Deflandre-Rigaud
Plate 2, figure 7

Micralcyonarites corallioides DEFLANDRE-RIGAUD, 1955, Acad. Sci., C. R., vol. 241, p. 1328, text-fig. 10; 1956, Ann. Pal., vol. 42, p. 17, pl. 2, figs. 13–14.

Description: Sclerites in the form of a dumbbell, with poles extended by a broad protuberance that is sometimes conical, more often thickened and strongly mamillate. There are two coronae, each composed of three large protuberances, arranged alternately (clearly visible in pl. 2, fig. 7). Structure markedly fibrous; color roseate or grayish white in polarized light.

Dimensions: Length 78–155μ; maximum width 48–70μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., nos. BX 10 (holotype), BX 9, and BX 17.

Micralcyonarites verticillatus Deflandre-Rigaud
Plate 2, figure 8

Micralcyonarites verticillatus Deflandre-Rigaud, 1955, Acad. Sci., C. R., vol. 241, p. 1328, text-fig. 11; 1956, Ann. Pal., vol. 42, p. 17, pl. 2, figs. 15–16.

Description: Sclerites more or less elongate, provided with two or more coronae composed of tuberculose protuberances, each ring usually bearing more than three protuberances which alternate in position. Extremities broad, mamillate, similar in appearance to the protuberances. Structure fibrous or only slightly fibrous. In polarized light, extinction is almost or not quite complete; very bright, with marginal colors, at about 45°.

Dimensions: Length of holotype 112μ; width 62μ. Length of paratype 124μ; width 58μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia. Paratype from the Middle Eocene, Lutetian, in limestone from Chaussy, Dept. Seine-et-Oise, France.

Depository: E.P.H.E. Micropal. Lab., nos. BX 17 (holotype), BX 8, and AV 57.

Micralcyonarites hystrix Deflandre-Rigaud
Plate 2, figure 3

Micralcyonarites hystrix Deflandre-Rigaud, 1955, Acad. Sci., C. R., vol. 241, p. 1328, text-fig. 9; 1956, Ann. Pal., vol. 42, p. 18, pl. 3, figs. 9–12; pl. 4, figs. 5–6.

Description: Sclerites flattened squamiform, highly variable in outline, provided with rounded denticles on the periphery, like crenulations; the entire sclerite is usually arcuate longitudinally, and the convex face bears a highly variable number of simple protuberances with rounded extremities, irregularly arranged. Structure highly fibrous. In polarized light, when the sclerite is lying flat, it shows neither complete extinction nor complete illumination, but it shows bright colors in the oblique position. In lateral view, extinction remains partial, but the sclerite may be completely illuminated at about 45°.

Dimensions: Length 116–205μ; width 58–102.5μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., nos. BX 8 (holotype), BX 7, BX 8, BX 9, BX 14, BX 20, and BX 21.

Micralcyonarites laminosus Deflandre-Rigaud
Plate 1, figure 10

Micralcyonarites laminosus Deflandre-Rigaud, 1955, Acad. Sci., C. R., vol. 241, p. 1328, text-fig. 8; 1956, Ann. Pal., vol. 42, p. 18, pl. 4, figs. 1–2.

Description: Sclerites squamiform, flattened, elongate or triangular in outline, periphery ornamented with irregular scallops; both faces are free of protuberances or tubercles. Structure distinctly fibrous. In polarized light, parallel to the nicols, this type shows a black extinguished axial band; in the oblique position, illumination is not complete, but consists of bright iridescent colors in closely spaced bands.

Dimensions: Length of holotype 273μ; width 93μ. Length of paratype 270μ; width 140μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., nos. BX 13 (holotype), and BX 21.

Micralcyonarites cornutitergum Deflandre-Rigaud
Plate 2, figure 5

Micralcyonarites cornutitergum Deflandre-Rigaud, 1955, Acad. Sci., C. R., vol. 241, p. 1328, text-fig. 15; 1956, Ann. Pal., vol. 42, p. 19, pl. 2, figs. 17–18.

Description: Sclerites highly curved, the concave portion provided with two (or one) tuberculate protuberances, the dorsum bearing numerous closely spaced, well developed expansions, which are simple or mamillated. Structure distinctly fibrous. In polarized light, extinction is incomplete and irregular; highly colored in the oblique position.

Dimensions: Length of holotype 133μ; maximum width 66μ. Length of paratypes 142–162μ; width 70–92μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., nos. BX 16 (holotype), BX 9, and BX 21.

Micralcyonarites tripes Deflandre-Rigaud
Plate 2, figure 6

Micralcyonarites tripes Deflandre-Rigaud, 1955, Acad. Sci., C. R., vol. 241, p. 1328, text-fig. 14; 1956, Ann. Pal., vol. 42, p. 19, pl. 4, figs. 3–4.

Description: Sclerite highly arcuate, in the form of a tripod; the convex part is ornamented with irregular conical or subconical protuberances. Structure highly fibrous. In polarized light, parallel to the nicols, extinction is incomplete, showing fibers and colors; in the oblique position, dark zones remain, and the sclerite as a whole is grayish white to colored.

Dimensions: Length 130μ; width 85μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., nos. BX 7 (holotype), and BX 11.

Micralcyonarites speciosus Deflandre-Rigaud
Plate 2, figure 9

Micralcyonarites speciosus DEFLANDRE-RIGAUD, 1955, Acad. Sci., C. R., vol. 241, p. 1328, text-fig. 13; 1956, Ann. Pal., vol. 42, p. 20, pl. 1, figs. 13–14.

Description: Sclerite compressed conical, triangular in outline, covered with verrucose processes over the entire surface; the protuberances at the apex are more highly developed than the others; in addition, there is a series of protuberances that are aligned, extending around the sclerite at about midheight. Structure finely fibrous. In polarized light, the colors are bright and the fibers visible; extinction is incomplete parallel to the nicols.

Dimensions: Length 95μ; width 73μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., no. BX 19 (holotype).

APPENDIX

Discoidal calcareous microfossils of which I have found no mention in the literature were found associated with *Micralcyonarites*. These tiny discs represent juvenile stages of Anthozoa, presumably Madreporaria of the suborder Fungiida. Three well-characterized types have already been recognized, and are described below.

Genus **Neanthozoites** Deflandre-Rigaud, 1956

Neanthozoites DEFLANDRE-RIGAUD, 1956, Ann. Pal., vol. 42, p. 21.

Description: Calcareous microfossils in the form of flattened discs or planoconvex biscuits, with radial structure and irregular, notched periphery. Size less than or equal to two-tenths of a millimeter.

Type: Neanthozoites elegans Deflandre-Rigaud, 1956.

Neanthozoites elegans Deflandre-Rigaud
Plate 2, figure 10

Neanthozoites elegans DEFLANDRE-RIGAUD, 1956, Ann. Pal., vol. 42, p. 21, pl. 3, figs. 13–19; pl. 4, figs. 7–8.

Description: Platelet discoidal, planoconvex, circular or slightly elliptical in outline with irregularly crenulated periphery, composed of rods radiating from a slightly protruding central nodule, which is irregular in form.

PLATE 1

All from the Balcombian, Balcombe Bay, Victoria, Australia.

1 *Micralcyonarites vulgaris* Deflandre-Rigaud
Holotype, × 188, BX 9.

2 *Micralcyonarites perverrucosus* Deflandre-Rigaud
Holotype, × 280, BX 8.

3 *Micralcyonarites robustus* Deflandre-Rigaud
Holotype, × 280, BX 10.

4 *Micralcyonarites conjunctus* Deflandre-Rigaud
Holotype, × 280, BX 10.

5 *Micralcyonarites alloiteaui* Deflandre-Rigaud
Holotype, × 280, BX 20.

6 *Micralcyonarites vulgaris* Deflandre-Rigaud
Paratype, × 280, BX 14.

7 *Micralcyonarites fusunculus* Deflandre-Rigaud
Holotype, × 280, BX 6.

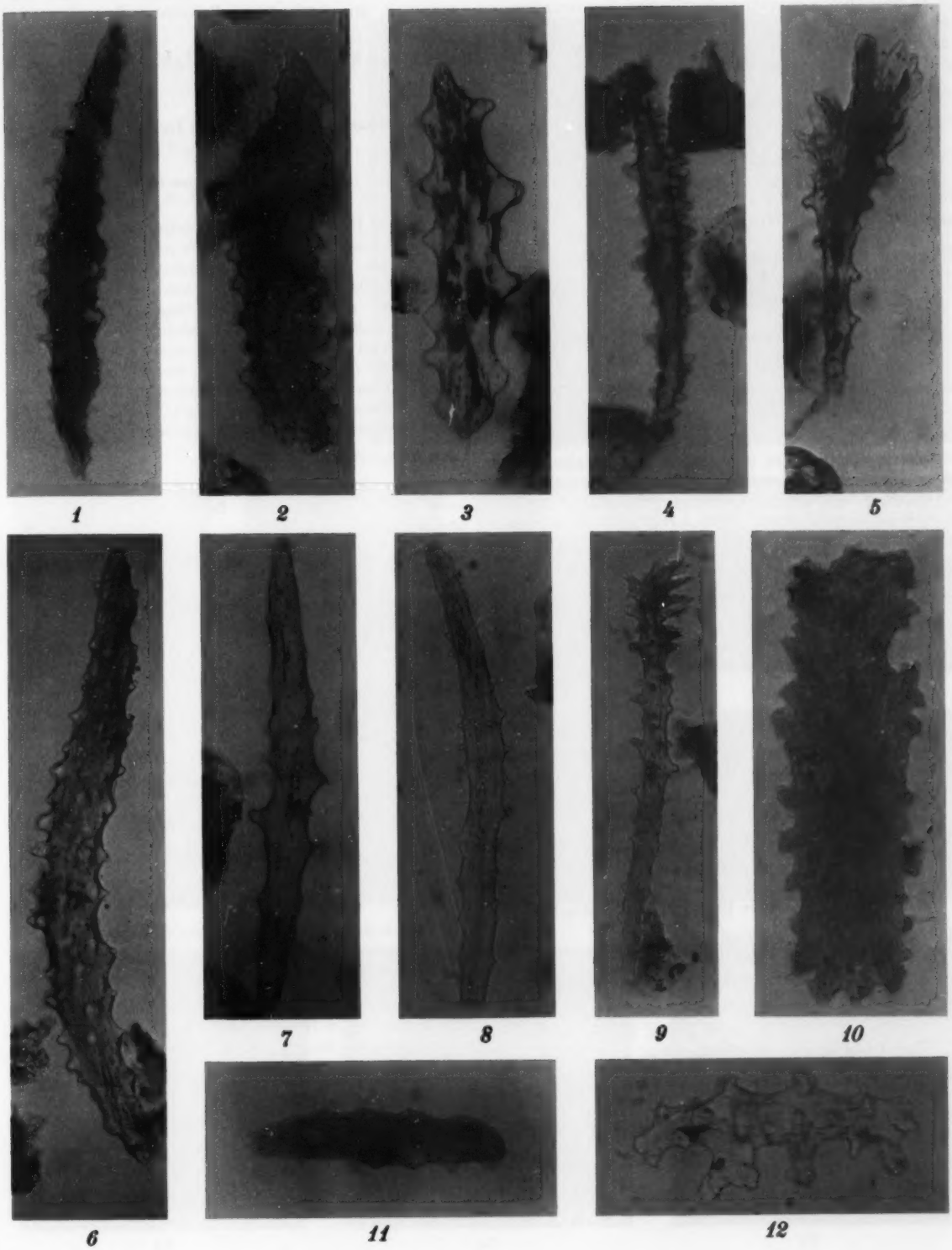
8 *Micralcyonarites fusticulus* Deflandre-Rigaud
Holotype, × 188, BX 14.

9 *Micralcyonarites scopula* Deflandre-Rigaud
Holotype, × 188, BX 17.

10 *Micralcyonarites laminosus* Deflandre-Rigaud
Holotype, × 280, BX 13.

11 *Micralcyonarites undatus* Deflandre-Rigaud
Holotype, × 280, BX 7.

12 *Micralcyonarites pedigerus* Deflandre-Rigaud
Holotype, × 475, BX 6.



1 2 3 4 5

6 7 8 9 10

11 12

In polarized light, under crossed nicols, showing the black cross that is characteristic of spherulitic structure, the illuminated portions showing the bright colors of calcite, which fade, however, or rather blend into a grayish white when the central portion is more convex.

Dimensions: Eocene specimens 73–108μ; Miocene specimens 47–63μ.

Occurrence: Holotype from the Middle Eocene, Lutetian, in limestone from Chaussy, Dept. Seine-et-Oise, France. Paratypes from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., nos. AV 56 (holotype), BX 3, and BX 22.

Neanthozoites fibratus Deflandre-Rigaud
Plate 2, figure 11

Neanthozoites fibratus DEFLANDRE-RIGAUD, 1956, Ann. Pal., vol. 42, p. 21, pl. 4, figs. 11–12.

Description: Platelet discoidal with jagged and irregular periphery, composed of very fine radiating calcareous fibers. Upper face convex, lower face slightly concave, center thickened. In polarized light, it shows a black cross with narrow arms, the colored sectors showing concentric bands of color, the margin straw-yellow.

Dimensions: 124–126μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., no. BX 6 (holotype).

Neanthozoites arachnoidiscus Deflandre-Rigaud
Plate 2, figure 12

Neanthozoites arachnoidiscus DEFLANDRE-RIGAUD, 1956, Ann. Pal., vol. 42, p. 22, pl. 4, figs. 9–10.

Description: Platelet discoidal, practically circular, with regularly notched periphery, with primary and secondary notches. Microstructure of the calcite neither heliolitic nor fibrillar. Disc divided into sectors, twelve to twenty in number, corresponding to the primary notches; each sector bears a median notch (secondary notch), and is provided with concentric transverse thickenings (cross-bars). All the sectors rest on a thin lamina, which is only slightly anisotropic. The calcite of the sectors has, in polarized light, a structure that is not homogeneous because of differences in thickness.

Dimensions: About 78–131μ.

Occurrence: Holotype from the Middle Miocene, Balcombian, in marls from Balcombe Bay, Victoria, Australia.

Depository: E.P.H.E. Micropal. Lab., no. BX 9 (holotype).

PLATE 2

1 *Micralcyonarites gallicus* Deflandre-Rigaud
Holotype, × 280, BN 90.
Lutetian marl, Fleury-la-Rivière, Dept. Marne, France.

2 *Micralcyonarites clava* Deflandre-Rigaud
Holotype, × 280, BX 16.
Balcombian, Balcombe Bay, Victoria, Australia.

3 *Micralcyonarites hystrix* Deflandre-Rigaud
Holotype, × 280, BX 8.
Balcombian, Balcombe Bay, Victoria, Australia.

4 *Micralcyonarites cretaceus* (Počta) Deflandre-Rigaud
Syntypes, × about 35 (after Počta, 1885).
Upper Cretaceous, Czechoslovakia.

5 *Micralcyonarites cornutitergum* Deflandre-Rigaud
Holotype, × 280, BX 16.
Balcombian, Balcombe Bay, Victoria, Australia.

6 *Micralcyonarites tripes* Deflandre-Rigaud
Holotype, × 280, BX 7.
Balcombian, Balcombe Bay, Victoria, Australia.

7 *Micralcyonarites corallioides* Deflandre-Rigaud
Holotype, × 280, BX 10.
Balcombian, Balcombe Bay, Victoria, Australia.

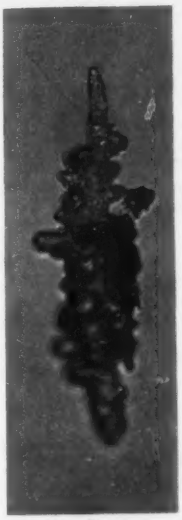
8 *Micralcyonarites verticillatus* Deflandre-Rigaud
Holotype, × 280, BX 17.
Balcombian, Balcombe Bay, Victoria, Australia.

9 *Micralcyonarites speciosus* Deflandre-Rigaud
Holotype, × 280, BX 19.
Balcombian, Balcombe Bay, Victoria, Australia.

10 *Neanthozoites elegans* Deflandre-Rigaud
Holotype, × 280, AV 56.
Lutetian, Chaussy, Dept. Seine-et-Oise, France.

11 *Neanthozoites fibratus* Deflandre-Rigaud
Holotype, × 280, BX 6.
Balcombian, Balcombe Bay, Victoria, Australia.

12 *Neanthozoites arachnoidiscus* Deflandre-Rigaud
Holotype, × 475, BX 9.
Balcombian, Balcombe Bay, Victoria, Australia.



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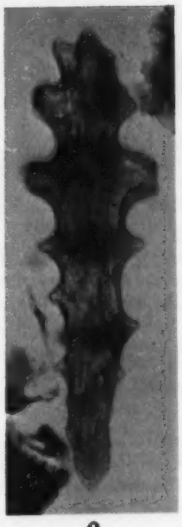

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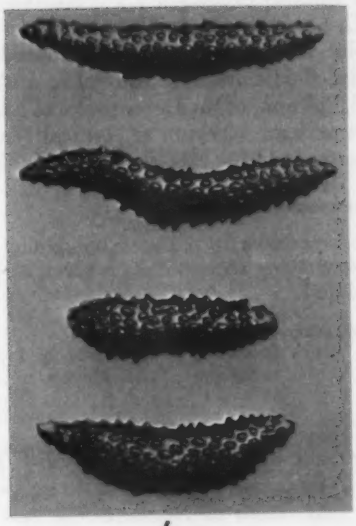

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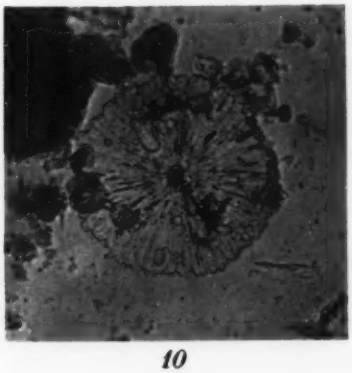

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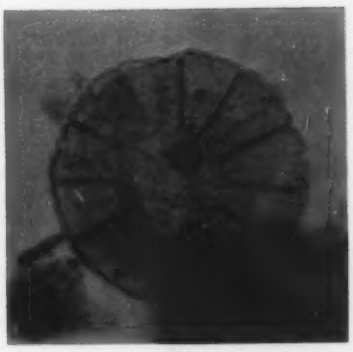

12

ACKNOWLEDGMENTS

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ABSTRACT: *During 1956, fifty-eight papers pertaining to Ostracoda were published, so far as now known. They contain descriptions of eighty-eight new genera and 375 new species. The new forms range in age from Lower Paleozoic to Recent.*

Bibliography and index to new genera and species of Ostracoda for 1956

STUART A. LEVINSON
Humble Oil & Refining Company
Houston, Texas

Fifty-eight papers pertaining to ostracodes are known to have been published during the year 1956 (text-fig. 1). This is in contrast to the fifty-six papers now known to have been published in 1955. During the past seven years, there was an increase in the number of papers to a peak of ninety-seven papers in 1953, with a decrease in activity during the past three years. It is believed that when all papers published in 1956 are known, the number of ostracode papers published during that year will be markedly increased.

Eighty-eight new genera are known to have been described in 1956 (text-fig. 2). This figure is more than double the previous maximum number of new genera described in one year during this seven-year period. A large portion of the new genera described in 1956 reflect the expansion of Russian ostracode research and the availability of Russian scientific literature. The new genera described in 1956 span the entire geologic column, with no emphasis on any particular age (text-fig. 3): Thirty-one Paleozoic genera, thirty-six Mesozoic genera, twenty Cenozoic genera, and one Recent genus.

During 1956, three hundred seventy-five new species were described (text-fig. 4), as opposed to two hundred four in 1955, two hundred seventy-seven in 1954, and three hundred seventy-seven in 1953.

The author is grateful to the many ostracode workers who have generously supplied him with reprints of their papers and of other papers as they appeared. He is particularly indebted to Dr. M. K. Elias, Dr. T. Hanai, Dr. G. Hartmann, Dr. H. V. Howe, Dr. V. Ivanova, Dr. A. J. Key, Dr. M. Mandelstam, Dr. A. Martinsson, R. W. Morris, Betty Kellett Nadeau, Dr. H. S. Puri, Dr. A. Rabien, and I. G. Sohn.

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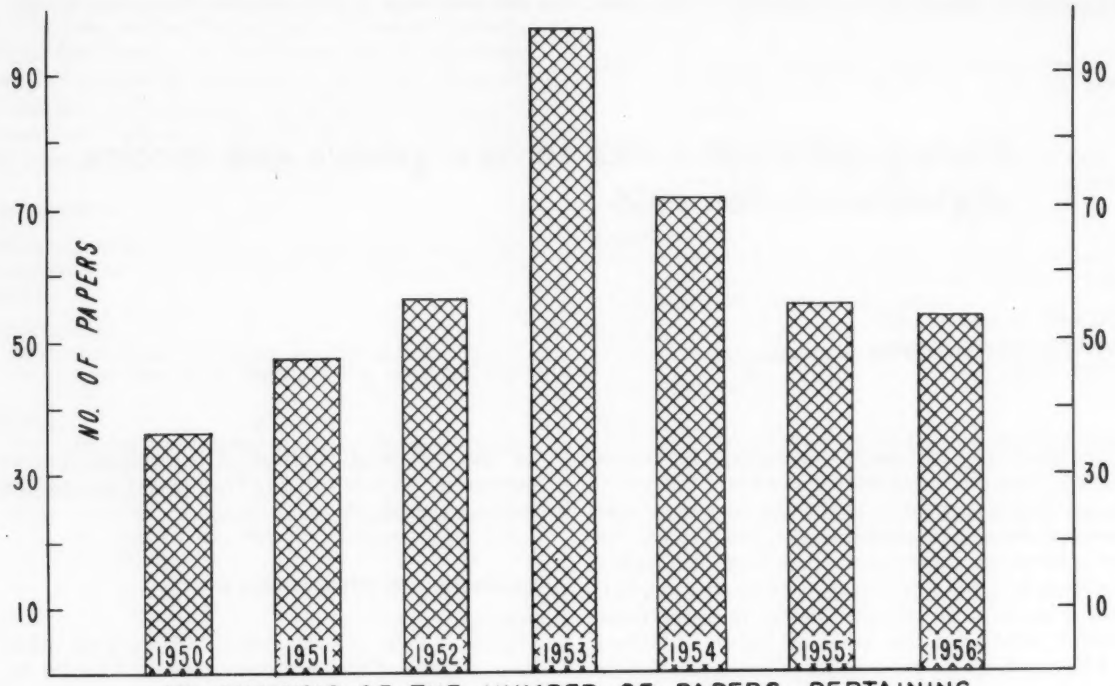
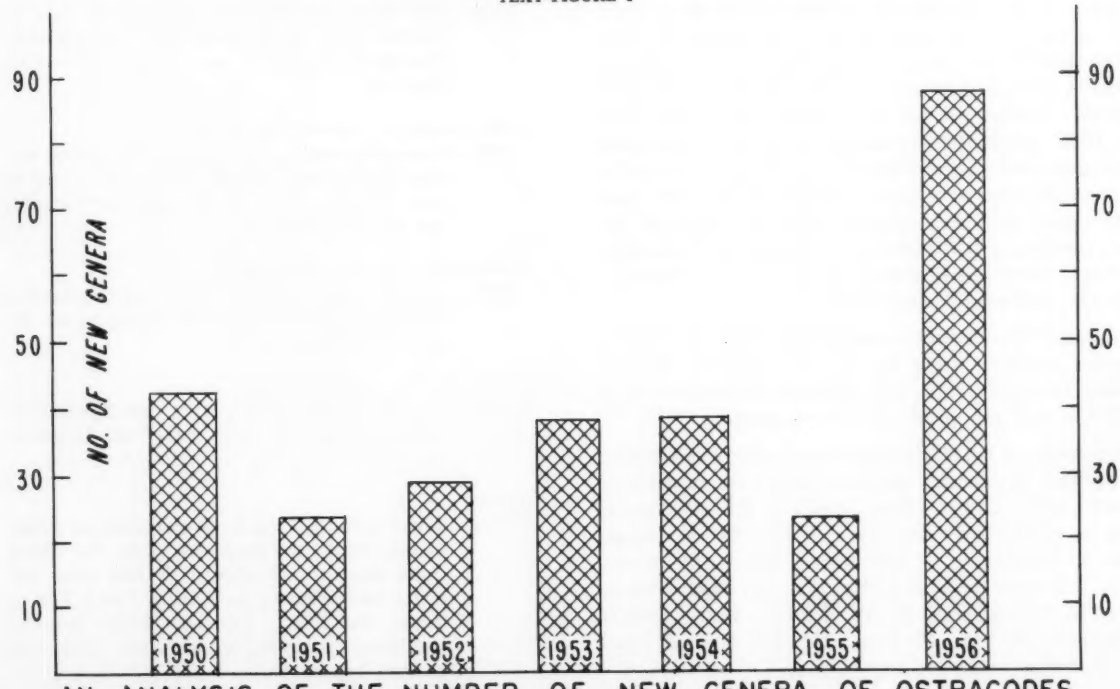


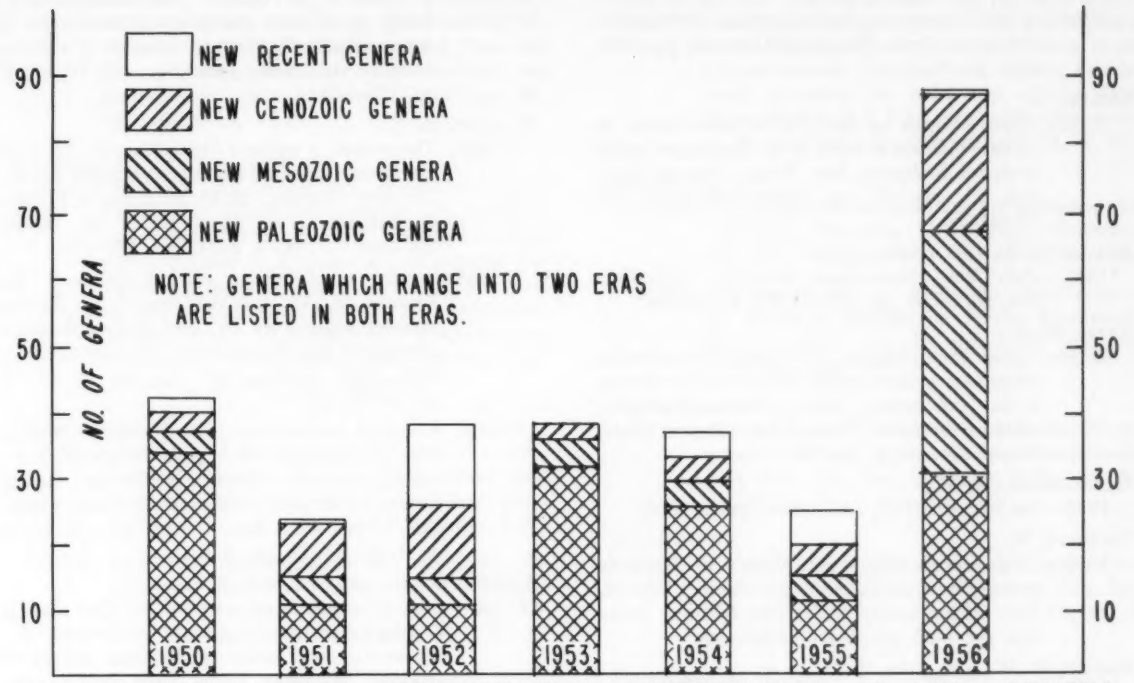
AN ANALYSIS OF THE NUMBER OF PAPERS PERTAINING TO OSTRACODES FROM 1950 - 1956

TEXT-FIGURE 1



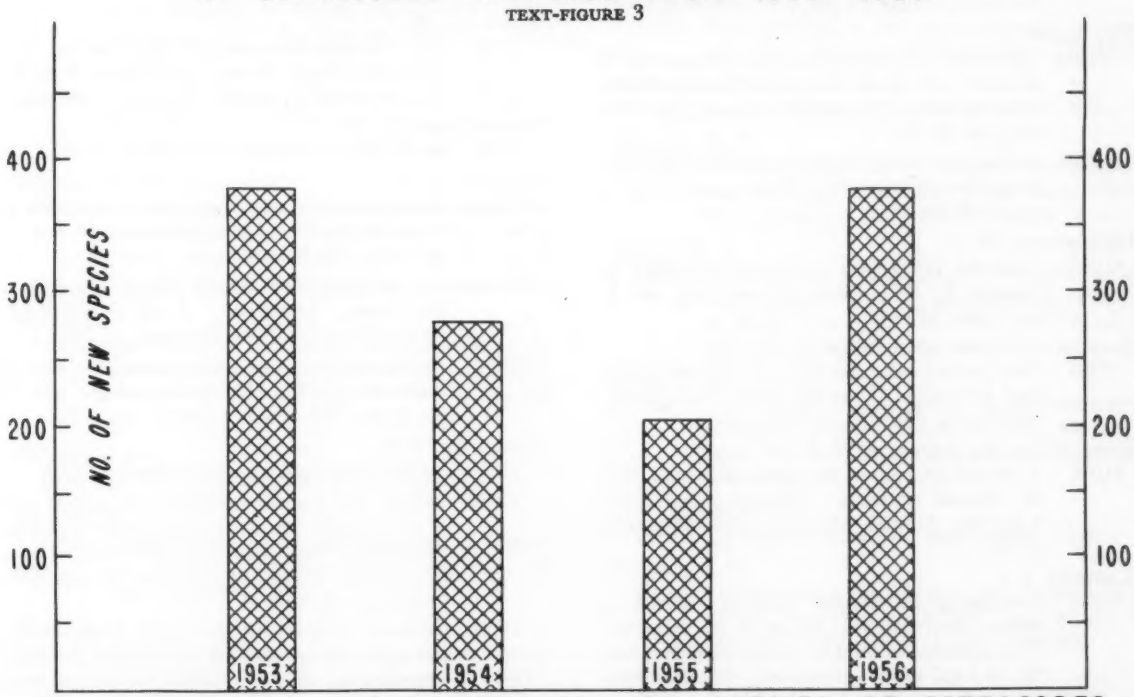
AN ANALYSIS OF THE NUMBER OF NEW GENERA OF OSTRACODES PROPOSED FROM 1950 - 1956

TEXT-FIGURE 2



AN ANALYSIS OF THE STRATIGRAPHIC DISTRIBUTION OF NEW GENERA OF OSTRACODES PROPOSED FROM 1950 - 1956

TEXT-FIGURE 3



AN ANALYSIS OF THE NUMBER OF NEW SPECIES OF OSTRACODES PROPOSED FROM 1953 - 1956

TEXT-FIGURE 4

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SYLVESTER-BRADLEY, P. C.
1956 – *Proposed use of the plenary powers to designate for the genus "Candona" Baird, [1846], a type species in harmony with accustomed usage, and validation of emendation to "Herpetocypris" of the generic name "Erpetocypris" Brady and Norman, 1899 (Class Crustacea, Order Ostracoda).* Bull. Zool. Nomencl., vol. 12, pts. 7/8, pp. 206–312.

SYLVESTER-BRADLEY, P. C., AND HOWE, H. V.
1956 – *Proposed addition to the respective "Official Lists" of the generic name "Limnocythere" Brady, 1868, and the family-group name "Limnocytherinae" Sars, 1925 (Class Crustacea, Order Ostracoda).* Bull. Zool. Nomencl., vol. 12, pt. 5, pp. 159–160.

SYLVESTER-BRADLEY, P. C., AND ILES, E. J.
1956 – *Proposed use of the plenary powers for validating the currently accepted spelling "Conchoecia" for the generic name "Conchaecia" Dana, 1849 (Class Crustacea, Order Ostracoda) and for the designation of a type species in harmony with accustomed usage.* Bull. Zool. Nomencl., vol. 12, pts. 7/8, pp. 213–220.

NEW SUBGENERA, GENERA AND SUPRAGENERIC CATEGORIES IN 1956

In the alphabetically arranged list of genera, the order of the items given in each entry is as follows: Name of the genus, its author and date; name of the type species, its author and date; page and figure in the reference in which the genus is proposed; stratigraphic horizon and geographic locality of the type species (in parentheses); range and habitat of the genus; family affiliation, if noted in the paper in which the new genus is described.

Acanthocythere Sylvester-Bradley, 1956; *Cythere sphaerulata* Jones and Sherborn, 1888; p. 12, pl. 1, figs. 1–4 (Middle Jurassic, England); Middle Jurassic, marine, family uncertain.

Acratinella Schneider, 1956; *A. dubia* Schneider, 1956; p. 92, pl. 20, fig. 2 (Lower Carboniferous, Tournaisian, northeastern part of the Russian Platform); Lower Carboniferous (Tournaisian) to Upper Carboniferous (*Schwagerina* horizon), marine, Bairdiidae.

Actuaria Schneider, 1956; *A. diffusa* Schneider, 1956; p. 91, pl. 21, fig. 2 (Upper Permian, Kazanian, Russian Platform); Carboniferous to Upper Permian, marine, Bairdiidae.

Adelphobolbina Stover, 1956; *Ctenobolbina papillosa* Ulrich, 1891; pp. 1103–1104 (Middle Devonian, Onondaga, Kentucky); Middle Devonian, marine, Hollinidae.

Advenocypris Schneider, 1956; *A. alpherovi* Schneider, 1956; pp. 98–99, pl. 22, figs. 4–6 (Upper Miocene, Sarmatian, eastern Ciscaucasus); Middle Miocene to Quaternary, fresh-water, Cyprididae.

Amphissella Stover, 1956; *A. papillosa* Stover, 1956; p. 1134, pl. 119, figs. 11–12 (Middle Devonian, New York); Middle Devonian, marine, family uncertain.

Amygalella Martinsson, 1956; *A. subclusa* Martinsson, 1956; p. 31 (Silurian, Netherlands); Silurian, marine, Primitiopsidae, Leiocyaminae. Martinsson (p. 32) notes: "Holotype – the female valve figured by Bonnema 1938, fig. 19 (Mus. Geol. Inst. Tartu (Dorpat), no. Os2805). Unfortunately, the best preserved specimens in Bonnema's figures (also in Swartz 1936, pl. 83) cannot be identified with certainty, as more than a hundred specimens of this species from Vollenhove are in the collections of the museum."

Baturinella Schneider, 1956; *B. kubanica* Schneider, 1956; pp. 99–100, pl. 20, fig. 1, text-fig. 21 (Upper Pliocene, Kubane River); Upper Pliocene, brackish-water, Cyprididae.

Bideirella Stover, 1956; *B. reticulata* Stover, 1956; p. 1137, pl. 119, figs. 7–10 (Middle Devonian, New York); Middle Devonian, marine, family uncertain.

Bonneprimites Swartz and Whitmore, 1956; *Primitia bonnemai* Swartz, 1936; p. 1051 (Silurian, Gotland); Silurian, marine, Leperditellidae, Conchoprimitiinae.

Bronsteiniana Mandelstam, in Mandelstam and others, 1956; *B. galba* Mandelstam, 1956; pp. 127–128, pl. 24, fig. 6 (Upper Cretaceous, Cenomanian and Turonian, Bukhara); Upper Cretaceous to Paleogene, marine, Cytheridae.

Carinocythereis Ruggieri, 1956; *Cytherina carinata* Roemer, 1838; pp. 163–165, text-fig. 1 (Miocene, Europe); Oligocene to Recent, marine, Trachyleberidae.

Caspiella Mandelstam, in Mandelstam and others, 1956 (non Thiele, 1928, Zool. Jahrb., Syst., vol. 55, p. 381); *Bairdia acronasuta* Livental, 1929; p. 104, pl. 25, figs. 3–4, text-fig. 24 (Upper Pliocene, Apsheronian, Caucasus); Pliocene to post-Pliocene, brackish-water, Cyprididae, Disopontocyprinae.

Caspiocypris Mandelstam, in Mandelstam and others, 1956; *Bairdia candida* Livental, 1929; pp. 105–106, pl. 25, figs. 1–2, text-fig. 26 (Upper Pliocene, Apsheronian, Caucasus); Pliocene to Recent, brackish-water, Cyprididae, Disopontocyprinae.

Centrocythere Mertens, 1956; *C. denticulata* Mertens, 1956; pp. 203–204, pl. 11, figs. 66–71; pl. 14, figs. 97–99 (Lower Cretaceous, Middle Albian, Germany); Lower Cretaceous, marine, Cytheridae, Progonocytherinae.

Climacoidea Puri, 1956; *C. plueurata* Puri, 1956; pp. 275–276, pl. 36, figs. 5–12 (Pliocene, Florida); Pliocene, marine, family uncertain.

Clinocypris Mandelstam, in Mandelstam and others, 1956; *C. scolia* Mandelstam, 1956; pp. 113–114, pl. 23, fig. 6, text-fig. 32 (Lower Cretaceous, Barremian, Dzhungaria, Central Asia); Triassic to Lower Cretaceous, fresh- and brackish-water, Cyprididae.

CTENOLOCULININAE Jaanusson and Martinsson, 1956; pp. 402–403; new subfamily of Hollinidae, erected to include: *Ctenoloculina* Bassler, 1941; *Parabolbina* Swartz, 1936; *Tetrasacculus* Stewart, 1936; *Bisacculus* Stewart and Hendrix, 1945; *Subligaculum* Kesling and McMillan, 1951; *Abditoloculina* Kesling, 1952; *Triemilomatella* Jaanusson and Martinsson, 1956.

Cyamocytheridea Oertli, 1956; *Bairdia punctatella* Bosquet, 1852; p. 50, pl. 5, figs. 128–143 (Oligocene, France and Belgium); Oligocene to Miocene, marine, Cytheridae.

Cyprideamorphella Mandelstam, in Mandelstam and others, 1956; *C. tarbagataiensis* Mandelstam, 1956; pp. 111–112, pl. 24, fig. 2, text-fig. 30 (Lower Cretaceous, Barremian, eastern Transbaikal); Lower Cretaceous, continental, Cyprididae.

Cytherettina Mandelstam, in Mandelstam and others, 1956 = *Protocythere* Triebel, 1938; *Cytherina triplicata* Roemer, 1841; pp. 134–135, text-fig. 47 (Upper Cretaceous, Germany); Cretaceous, marine, Cytheridae.

Cytherissinella Schneider, 1956; *C. okrajanizi* Schneider, 1956; pp. 126–127, pl. 20, fig. 5 (Lower Triassic, Emba); Lower Triassic, brackish-water, Cytheridae.

Cytheropterina Mandelstam, in Mandelstam and others, 1956; *C. vegranda* Mandelstam, 1956; pp. 132–133, pl. 24, fig. 5, text-fig. 45 (Upper Jurassic, Kimmeridgian, eastern Ukraine); Jurassic to Lower Cretaceous, marine, Cytheridae.

Darwinuloides Mandelstam, 1956; *Darwinula oviformis* Mandelstam, 1947; p. 184, pl. 48, fig. 9 (Upper Permian(?), Siberia); Upper Permian(?), habitat uncertain, Darwinulidae.

Dictyocythere Sylvester-Bradley, 1956 (new genus and subgenus); *Cythere retirugata* Jones, 1885; pp. 13–14, pl. 3, figs. 7–10; pl. 4, figs. 3–4, 11, 16–17 (Upper Jurassic, England); Upper Jurassic, marine, family uncertain.

DISOPONTOCYPRINAE Mandelstam, in Mandelstam and others, 1956; p. 102; new subfamily of the Cyprididae, erected to include: *Disopontocypris* Mandelstam; *Caspiocypris* Mandelstam; *Caspiella* Mandelstam; *Pontonella* Mandelstam.

Disopontocypris Mandelstam, in Mandelstam and others, 1956; *Pontocypris oligocaenica* Zalanyi, 1929; p. 103, pl. 25, figs. 8–9, text-fig. 23 (Upper Oligocene, Hungary); Oligocene, marine, Cyprididae, Disopontocyprinae.

Dolocythere Mertens, 1956; *D. rara* Mertens, 1956; pp. 191–192, pl. 10, figs. 33–37; pl. 13, figs. 91–93 (Lower Cretaceous, lower Albian, Germany); Middle Jurassic to Lower Cretaceous, marine, Cytheridae.

Doraclatum Stover, 1956; *D. compandium* Stover, 1956; p. 1136, pl. 119, figs. 1–5 (Middle Devonian, New York); Middle Devonian, marine, family uncertain.

Emphasia Mandelstam, in Mandelstam and others, 1956; *E. ceratophaga* Mandelstam, 1956; pp. 128–129, pl. 23, fig. 2, text-fig. 41 (Middle Jurassic, Kazakhstan); Middle Jurassic, fresh-water, Cytheridae.

Exuocypris Mandelstam, in Mandelstam and others, 1956; *E. extorris* Mandelstam, 1956; pp. 114–115, text-figs. 33–34 (Middle Pliocene, western Turkmenia, Cheleken Peninsula); Middle Pliocene, brackish-water, Cyprididae.

Gemmanella Schneider, 1956; *G. schweyeri* Schneider, 1956; p. 123, pl. 19, fig. 1 (Lower Triassic, Emba); Lower Triassic, brackish-water, Cytheridae.

Glorianella Schneider, 1956; *G. efforta* Glebovskaia, 1956; pp. 121–122, pl. 19, fig. 4, text-fig. 39 (Lower Triassic, Emba); Lower Triassic, continental, Cytheridae.

Gubkiniella Kuznetsova, 1956; *G. miranda* Kuznetsova, 1956; pp. 142–143, pl. 24, fig. 3 (Lower Cretaceous, Barremian, southeastern Caucasus); Lower Cretaceous, marine, Cytheridae.

Howella Puri, 1956 (non Ogilby, 1889, Linn. Soc. New South Wales, Proc., vol. 23, p. 734); *Cythere evax* Ulrich and Bassler, 1904; pp. 274–275, pl. 35, figs. 1–8 (Middle Miocene, Maryland); Upper Eocene to Upper Miocene, marine, Trachyleberinae.

Ilyocyprimorpha Mandelstam, in Mandelstam and others, 1956; *I. palustris* Mandelstam, 1956; pp. 110–111, pl. 24, fig. 1, text-fig. 29 (Lower Cretaceous, southern part of eastern Transbaikal); Lower Cretaceous, Barremian, continental, Cyprididae.

Iniella Mandelstam, 1956; *I. kuznetskiensis* (Spizharsky); pp. 99–100, pl. 13, figs. 5, 7 (Upper Permian(?), Siberia); Upper Permian, habitat uncertain, Cyprididae, Tomiellinae.

Kassinia Mandelstam, in Mandelstam and others, 1956 (non Khabakov, 1937, Soc. Pal. Russe, Ann., vol. 11, p. 110); *K. kassini* Mandelstam, 1956; pp. 118–119, pl. 23, fig. 4, text-fig. 38 (Middle Oligocene, Kazakhstan); Middle Oligocene, continental, Cyprididae.

Kemeroviana Mandelstam, 1956; *K. argulata* Mandelstam, 1956; p. 97, pl. 19, fig. 1 (Upper Permian(?), Siberia); Upper Permian, habitat uncertain, Cyprididae, Tomiellinae.

Leiocyaminae Martinsson, 1956; pp. 29–30; new subfamily of the Primitiopsidae, erected to include: *Leiocyamus* Martinsson, 1956; *Amygalella* Martinsson, 1956.

Leiocyamus Martinsson, 1956; *L. apicatus* Martinsson, 1956; p. 30, pls. 4–5, figs. 38–42 (Middle Silurian, Sweden); Middle Silurian, marine, Primitiopsidae, Leiocyaminae.

Limbinaria Swartz, 1956; *L. multipunctata* Swartz, 1956; p. 1054, text-fig. 4a–b (Upper Silurian, Virginia and Tennessee); Upper Silurian, marine, Primitiopsidae.

Limnocypridea Liubimova, 1956*a*; *L. abscondida* Liubimova, 1956; pp. 106–108, pl. 26, fig. 2, text-fig. 27 (Lower Cretaceous, Mongolia); Lower Cretaceous, continental, Cyprididae.

Lophokloedenia Swartz and Whitmore, 1956; *Beyrichia manliensis* Weller, 1903; p. 1068, pl. 107, figs. 1–9 (Upper Silurian, New York and New Jersey); Upper Silurian, marine, Zygobolbidae.

Lutkevichinella Schneider, 1956; *L. bruttanae* Schneider, 1956; p. 125, pl. 19, fig. 2, text-fig. 40 (Lower Triassic, Emba); Lower Triassic, brackish-water, Cytheridae.

Lycopterocypris Mandelstam, in Mandelstam and others, 1956; *Cypris faba* Egger, 1910; pp. 116–117, pl. 25, fig. 10, text-figs. 35–37 (Lower Cretaceous, Vitim River, Transbaikal); Lower and Upper Cretaceous, continental, Cyprididae.

Mandelstamia Liubimova, 1956*a*; *M. facilis* Liubimova, 1956; pp. 141–142, pl. 26, fig. 3, text-fig. 53 (Upper Jurassic, *Virgatites virgatus* zone, Big Irgiz River, Kuibyshev region); Jurassic, marine, Cytheridae.

Mediocypris Schneider, 1956; *M. brodi* Schneider, 1956; p. 96, pl. 21, fig. 1, text-fig. 19 (Middle Miocene, Chockrackian, northern Ossetia, Caucasus); Middle Miocene, fresh-water, Cyprididae.

Mediocytherideis Mandelstam, in Mandelstam and others, 1956; *Cytherideis apatoica* Schveyer, 1949; p. 137, text-fig. 50 (Pliocene, Apsheronian, Lower Volga, Astrakhanian region); Neogene, brackish-water, Cytheridae.

Mesocythere Hartmann, 1956*b*; *M. foveata* Hartmann, 1956; pp. 28–31, text-figs. 19–27 (Recent, Brazil); Recent, marine, Cytherinae.

Mongolianella Mandelstam, in Mandelstam and others, 1956; *M. palmosa* Mandelstam, 1956; pp. 112–113, pl. 23, fig. 5, text-fig. 31 (Lower Cretaceous, Barremian, southern part of eastern Transbaikal); Lower and Upper Cretaceous, continental, Cyprididae.

Mutilus Neviani, 1928, for "Gruppo *Mutilus*" Neviani, in Ruggieri, 1956, p. 167; lectogenotype designated: *M. reformis* (Terquem), p. 169.

Myomphalus Swartz and Whitmore, 1956; *M. dorsinodosus* Swartz and Whitmore, 1956; pp. 1073–1074, pl. 103, figs. 15–17 (Upper Silurian, New York and New Jersey); Upper Silurian, marine, Zygobolbidae.

Neocyprideis Apostolescu, 1956, new subgenus of *Cyprideis*; *N. durocortoriensis* Apostolescu, 1956; p. 1337, pl. 2, figs. 19–22; pl. 4, figs. 57–61 (Lower Eocene, France); Lower Eocene, marine, Cytheridae, Cytherideinae.

Neocythere Mertens, 1956; *N. vanveeni* Mertens, 1956; p. 205, pl. 12, figs. 72–78; pl. 14, figs. 100–102 (Lower Cretaceous, upper Albian, Germany); Lower and Upper Cretaceous, marine, Cytheridae, Progonocytheridae. The trivial name of the type species should read "*vanveenae*."

Ordovicia Netskaia, 1956; *Ctenentoma macroreticulata* Hessland, 1949; pp. 88–89 (Lower Ordovician, Sweden); Lower and Middle Ordovician, marine, Tetradellidae.

Origoilyocypris Mandelstam, in Mandelstam and others, 1956; *O. cirrita* Mandelstam, 1956; p. 109, pl. 24, fig. 4, text-fig. 28 (Lower Cretaceous, Barremian, Dzhungaria, Central Asia); Upper Jurassic to Upper Cretaceous, continental, Cyprididae.

Paleomonsmirabilia Apostolescu, 1956; *P. paupera* Apostolescu, 1956; p. 1338, pl. 2, figs. 30–31; pl. 4, figs. 62–63 (Lower Eocene, France); Lower Eocene, marine, Cytheridae.

Parabufina Smith, 1956; *P. convexa* Smith, 1956; p. 6, pl. 1, figs. 16–18 (Middle Devonian, New York); Middle Devonian, marine, Ropolonellidae.

Parataxodonta Mandelstam, in Mandelstam and others, 1956; *P. uralensis* Mandelstam, 1956; pp. 136–137, pl. 23, fig. 1, text-fig. 49 (Lower Cretaceous, Aptian, Kazakhstan, Uralsk region); Lower Cretaceous, Aptian and Albian, marine, Cytheridae.

Placidea Schneider, 1956; *Amphissites lutkevichi* Spizharsky, 1939; p. 95, pl. 20, figs. 3–4, text-fig. 18 (Upper Permian, Tartarian, Sukhona River); Upper Permian, fresh-water, Placideidae.

Placideidae Schneider, 1956; p. 95; new family erected for the genus *Placidea* Schneider, 1956.

Pokornyella Oertli, 1956; *Cythere limbata* Bosquet, 1852; p. 97, pl. 14, figs. 366–377 (Oligocene, France and Belgium); Oligocene, marine, Trachyleberididae.

Pontocyprella Mandelstam, in Mandelstam and others, 1956; *Bairdia harrisiana* Jones, 1849; p. 106, pl. 23, fig. 3 (Upper Cretaceous, England); Jurassic, Cretaceous, and Paleogene, marine, Cyprididae, Disopontocyprinae.

Pontonella Mandelstam, in Mandelstam and others, 1956 (non Heller, 1856, Zool.-Bot. Ver. Wien, Verh., vol. 6, Abh., p. 629); *Paracypria acuminata* Zalanyi, 1929; pp. 104–105, pl. 25, figs. 5–7, text-fig. 25 (Lower Pliocene, Pontian, Hungary); Lower Pliocene to post-Pliocene, brackish-water, Cyprididae, Disopontocyprinae.

Procytheropteron Mandelstam, in Mandelstam and others, 1956; *Cythere punctatula* var. *virginea* Jones, 1849; p. 131, text-fig. 44 (Upper Cretaceous, Maestrichtian, England); Jurassic and Cretaceous, marine, Cytheridae.

Prosopeionum Stover, 1956; *P. plexum* Stover, 1956; p. 1123, pl. 116, figs. 31–37 (Middle Devonian, New York); Middle Devonian, marine, Quasillitidae.

Protoargilloecia Mandelstam, in Mandelstam and others, 1956; *Bairdia silicula* var. *minor* Jones and Hinde, 1890; p. 117, pl. 23, figs. 7–8 (Upper Cretaceous, England); Jurassic to Miocene, marine, Cyprididae.

Pseudobeyrichia Swartz and Whitmore, 1956; *P. perornata* Swartz and Whitmore, 1956; p. 1061, pl. 104, figs. 11–12 (Upper Silurian, New Jersey); Upper Silurian, marine, Beyrichiidae.

Pseudobythocythere Mertens, 1956; P. *goerlichi* Mertens, 1956; pp. 200–201, pl. 11, figs. 62–65; pl. 13, figs. 94–96 (Lower Cretaceous, lower Albian, Germany); Lower Cretaceous, marine, Cytheridae, Bythocytherinae.

Pseudoleperditia Schneider, 1956; *P. tuberculifera* Schneider, 1956; p. 87, pl. 22, fig. 1 (Lower Carboniferous, Tournaisian, northeastern part of the Russian Platform); Lower Carboniferous, Tournaisian, marine, Primitiidae.

Punctomosea Stover, 1956; *Thrallella cristata* Swartz and Oriel, 1948; pp. 1113–1114, pl. 113, figs. 26–29 (Middle Devonian, New York); Middle Devonian, marine, Cytherellidae.

Pyrocytheridea Liubimova, 1956*a*; *P. pergraphica* Liubimova, 1956; pp. 139–140, pl. 26, fig. 1, text-fig. 52 (Upper Jurassic, Callovian, Middle Volga, Samara region); Jurassic and Lower Cretaceous, marine, Cytheridae.

QUASILLITACEA Sylvester-Bradley, 1956; new superfamily erected for the families Quasillitidae, Graphiadactyllidae, and Ropolonellidae; p. 11.

Rhysocythere Sylvester-Bradley, 1956; new subgenus of *Dictyocythere*; *Cythere retirugata* var. *rugulata* Jones, 1885; p. 18, pl. 4, figs. 1–2, 5–10, 12–15 (Upper Jurassic, England); Upper Jurassic, marine, family uncertain.

Robsoniella Kuznetsova, 1956; *R. obovata* Kuznetsova, 1956; pp. 119–120, pl. 27, figs. 1–3 (Lower Cretaceous, upper Aptian, southeastern Caucasus); Lower Cretaceous, Aptian and Albian, marine, Cyprididae.

Saccarchites Swartz and Whitmore, 1956; *S. saccularis* Swartz and Whitmore, 1956; p. 1079, pl. 103, figs. 18–19 (Upper Silurian, New York and New Jersey); Upper Silurian, marine, Zygobolbidae.

Scalptina Stover, 1956; *S. incuda* Stover, 1956; pp. 1122–1123, pl. 116, figs. 27–30 (Middle Devonian, New York); Middle Devonian, marine, Quasillitidae.

Semicytheridea Mandelstam, in Mandelstam and others, 1956; *Cythere spinifera* Chapman, 1893; pp. 129–130, text-fig. 42 (Lower Cretaceous, upper Aptian and Albian, England); Lower Cretaceous, marine, Cytheridae.

Speluncella Schneider, 1956; *S. spinosa* Schneider, 1956; pp. 120–121, pl. 19, fig. 3 (Lower Triassic, Emba); Lower Triassic, continental, Cytheridae.

Suzinia Schneider, 1956; "*Ilowaiskya*" *transcaucasica* Suzin (apparently originally a *nomen nudum*, as it is indicated later as *Suzinia transcaucasica* Suzin, sp. nov.); p. 101, pl. 22, figs. 2–3, text-fig. 22 (Lower Oligocene, Armenia); Oligocene, marine, Cyprididae.

Swartzochilina Scott, 1956; *Dihogmochilina straitcreekensis* Swartz, 1949; pp. 1374–1375 (Upper Silurian, Virginia); Upper Silurian, marine, Leperditiidae.

Tenebrion Zanina, 1956; *Graphiodactylus? grandis* Posner; pp. 89–90, text-fig. 16 (Lower Carboniferous, Visean, Leningrad region); Lower Carboniferous, marine, Kirkbyidae.

Thlipsuropsis Swartz and Whitmore, 1956; *T. diploglyptulis* Swartz and Whitmore, 1956; p. 1087, pl. 110, figs. 10–12 (Upper Silurian, New York and New Jersey); Upper Silurian, marine, Thlipsuridae.

Tomiellina Mandelstam, 1956; *T. umbrata* Mandelstam, 1956; pp. 95–96, pl. 18, fig. 6 (Upper Permian(?), Siberia); Upper Permian, habitat uncertain, Cypridiidae, Tomiellinae.

TOMIELLINAE Mandelstam, 1956; p. 81; new subfamily of the Cytheridae erected to include: *Tomiella* Spizharsky, 1937; *Tomiellina* Mandelstam, 1956; *Kemeroviana* Mandelstam, 1956; *Iniella* Mandelstam, 1956.

Triassinella Schneider, 1956; *T. chramovi* Schneider, 1956; p. 124, pl. 22, fig. 7 (Lower Triassic, Big Bogdo Mountain, Emba region); Lower Triassic, brackish-water, Cytheridae.

Triemilomatella Jaanusson and Martinsson, 1956; *T. prisca* Jaanusson and Martinsson, 1956; pp. 403–404, pl. 1, figs. 1–6 (Middle Silurian, Sweden); Middle Silurian, marine, Ctenoloculininae.

Trochiscus Mandelstam, in Mandelstam and others, 1956 (non Heyden, 1826, Isis von Oken, p. 613); *Cythere punctatula* Jones, 1849; p. 135, text-fig. 48 (Upper Cretaceous, Cenomanian, England); Cretaceous, marine, Cytheridae.

Ussuriocypris Mandelstam, in Mandelstam and others, 1956; *U. ussurica* Mandelstam, 1956; pp. 117–118, pl. 25, figs. 11–13 (Lower Cretaceous, Ussurian Bay, Far East); Lower Cretaceous, continental, Cyprididae.

Vetustocytheridea Apostolescu, 1956; new subgenus of *Cytheridea*; *V. guitrancourtensis* Apostolescu, 1956; p. 1336, pl. 2, figs. 27–29; pl. 4, figs. 53–56 (Lower Eocene, France); Lower Eocene, marine, Cytheridae, Cytherideinae.

Volganella Sharapova and Mandelstam, 1956; *V. magna* Spizharsky, 1956; p. 94, pl. 12, figs. 3–4, text-fig. 17 (Upper Permian, Tartarian, Sukhona River, Russian Platform); Upper Permian, continental, Volganellidae.

VOLGANELLIDAE Mandelstam, in Mandelstam and others, 1956; p. 94; new family erected for the genus *Volganella* Sharapova and Mandelstam, 1956.

Welleriopsis Swartz and Whitmore, 1956; *W. diplocystulis* Swartz and Whitmore, 1956; pp. 1074–1075, pl. 105, figs. 9–13 (Upper Silurian, New Jersey); Upper Silurian, marine, Zygobolbidae.

NEW SPECIES, SUBSPECIES AND VARIETIES IN 1956

Acanthocythere spiniscutulata Sylvester-Bradley, 1956; p. 13, pl. 1, figs. 5–9 (Middle Jurassic, England); family uncertain.

Acratinella dubia Schneider, 1956; p. 92, pl. 20, fig. 2 (Lower Carboniferous, Tournaisian, northeastern part of the Russian Platform); Bairdiidae.

Actuaria diffusa Schneider, 1956; p. 91, pl. 21, fig. 2 (Upper Permian, Russian Platform); Bairdiidae.

Adelphobolbina medialis Stover, 1956; p. 1104, pl. 112, figs. 4–9 (Middle Devonian, New York); Hollinidae.

Advenocypris alpherovi Schneider, 1956; p. 99, pl. 22, figs. 4–6 (Upper Pliocene, Kubane River); Cyprididae.

Aechmina eupunctella Swartz and Whitmore, 1956; p. 1054, pl. 103, figs. 4–6 (Upper Silurian, New Jersey); Aechminidae.

Aechmina magnaspina Smith, 1956; p. 4, pl. 1, fig. 4 (Middle Devonian, New York); Aechminidae.

Aequacytheridea elavata Liubimova, 1956*b*; p. 565, pl. 3, fig. 9 (Upper Jurassic, Ukraine); Cytheridae.

Aequacytheridea maculata Apostolescu, 1956; p. 1335, pl. 2, figs. 23–24 (Lower Eocene, France); Cytheridae.

Aequacytheridea pigmea Liubimova, 1956*b*; p. 566, pl. 3, fig. 10 (Upper Jurassic, Ukraine); Cytheridae.

Aequacytheridea translucida Liubimova, 1956*b*; p. 564, pl. 3, figs. 7, 8a–c (Upper Jurassic, Ukraine); Cytheridae.

Amphissella papillosa Stover, 1956; p. 1134, pl. 119, figs. 11–12 (Middle Devonian, New York); family uncertain.

Amphissites ringwoodensis Harris and Jobe, 1956; p. 13, pl. 2, fig. 10a–d (Upper Mississippian, Oklahoma); Kirkbyidae.

Amphizona pseudocarinata Smith, 1956; p. 5, pl. 1, figs. 5–7 (Middle Devonian, New York); Kirkbyidae.

Amygalella subclusa Martinsson, 1956; p. 31 (see discussion of *Amygalella* Martinsson) (Silurian, Europe); Primitiopsidae, Leiocyaminae.

Bairdia granireticulata var. *ringwoodensis* Harris and Jobe, 1956, n. var.; p. 15, pl. 3, fig. 4a–c (Upper Mississippian, Oklahoma); Bairdiidae.

Bairdia huffmani Harris and Jobe, 1956; p. 15, pl. 3, fig. 5a–c (Upper Mississippian, Oklahoma); Bairdiidae.

Bairdia jobeae Harris and Jobe, 1956; p. 16, pl. 3, fig. 6a–c (Upper Mississippian, Oklahoma); Bairdiidae.

Bairdia moreyi Harris and Jobe, 1956; p. 17, pl. 3, fig. 7a–b (Upper Mississippian, Oklahoma); Bairdiidae.

Bairdia obliqua Liubimova, 1956*b*; p. 542, pl. 1, fig. 11 (Upper Jurassic, Ukraine); Bairdiidae.

Bairdia opulenta Liubimova, 1956*b*; p. 543, pl. 1, fig. 10 (Upper Jurassic, Ukraine); Bairdiidae.

Bairdia positiva Liubimova, 1956*b*; p. 543, pl. 1, fig. 9 (Upper Jurassic, Ukraine); Bairdiidae.

Bairdiolites centroporatus Harris and Jobe, 1956; p. 18, pl. 3, figs. 8a–c, 9a–b (Upper Mississippian, Oklahoma); Bairdiidae.

Bairdoppilata pseudoseptentrionalis Mertens, 1956; p. 182, pl. 8, figs. 7–10; pl. 13, figs. 89–90 (Lower Cretaceous, upper Albian, Germany); Bairdiidae.

Baturinella kubanica Schneider, 1956; p. 100, pl. 20, fig. 1, text-fig. 21 (Upper Pliocene, western Ciscaucasus); Cyprididae.

Beyrichia (*Beyrichia*) *dactyloscopica* Martinsson, 1956; p. 20, pls. 1–2, figs. 2–9 (Middle Silurian, Sweden); Beyrichiidae.

Beyrichia (*Beyrichia*) *subornata* Martinsson, 1956; p. 22, pl. 2, figs. 10–12 (Middle Silurian, Sweden); Beyrichiidae.

Bideirella reticulata Stover, 1956; p. 1137, pl. 119, figs. 7–10 (Middle Devonian, New York); family uncertain.

Birdsallella catena Stover, 1956; p. 1113, pl. 114, figs. 1–3 (Middle Devonian, New York); Cytherellidae.

Bolbiprimitia limbata Swartz and Whitmore, 1956; p. 1082, pl. 104, figs. 13–17 (Upper Silurian, New Jersey); Zygobolbidae.

Bolbiprimitia teresaccula Swartz and Whitmore, 1956; p. 1082, pl. 104, fig. 18 (Upper Silurian, New York); Zygobolbidae.

Bonneprimites? breviformis Swartz and Whitmore, 1956; p. 1053, pl. 110, figs. 20–22 (Upper Silurian, New Jersey); Leperditellidae, Conchoprimitiinae.

Brachycythere incisa Apostolescu, 1956; p. 1343, pl. 3, figs. 51–52 (Lower Eocene, France); Trachyleberididae.

Brachycythere pietschkeri Skinner, 1956; p. 187, pl. 2, fig. 1a–g (Upper Cretaceous, Arkansas); Cytheridae.

Bradleya thiliensis Apostolescu, 1956; p. 1341, pl. 3, figs. 40–42 (Lower Eocene, France); Trachyleberididae.

Bronsteiniana galba Mandelstam, in Mandelstam and others, 1956; p. 128, pl. 24, fig. 6 (Upper Cretaceous and Paleogene, Middle Asia); Cytheridae.

Bythocypris phaseoella Stover, 1956; p. 1120, pl. 115, figs. 19–20 (Middle Devonian, New York); Bairdiidae.

Bythocypris transptyxis Stover, 1956; p. 1120, pl. 115, figs. 15–16 (Middle Devonian, New York); Bairdiidae.

Bythocypris transptyxis var. *truncata* Stover, 1956, n. var.; p. 1120, pl. 115, figs. 17–18 (Middle Devonian, New York); Bairdiidae.

Bythocypris tubercula Stover, 1956; p. 1120, pl. 115, figs. 21–22 (Middle Devonian, New York); Bairdiidae.

Camptocythere nordvikensis Sharapova, 1956; p. 131, pl. 26, fig. 4, text-fig. 43 (Middle Jurassic, northern part of the U.S.S.R.); Cytheridae.

Cavellina moorei Harris and Jobe, 1956; p. 21, pl. 4, fig. 12a–c (Upper Mississippian, Oklahoma); Cytherellidae.

Centrocythere denticulata Mertens, 1956; p. 204, pl. 11, figs. 66–71; pl. 14, figs. 97–99 (Lower Cretaceous, Germany); Cytheridae, Progonocytherinae.

Chironiptrum? arcuatum Stover, 1956; p. 1135, pl. 119, figs. 27–29 (Middle Devonian, New York); family uncertain.

Climacoidea plueurata Puri, 1956; p. 276, pl. 35, figs. 5–12 (Pliocene, Florida); family uncertain.

Clinocypris scolia Mandelstam, in Mandelstam and others, 1956; p. 114, pl. 23, fig. 6, text-fig. 32 (Lower Cretaceous, Barremian, Dzhungaria, Central Asia); Cyprididae.

Clithrocytheridea canceratica Apostolescu, 1956; p. 1334, pl. 1, figs. 15–18 (Lower Eocene, France); Cytheridae.

Clithrocytheridea hieroglyphica Apostolescu, 1956; p. 1334, pl. 1, figs. 10–12 (Lower Eocene, France); Cytheridae.

Clithrocytheridea magna Apostolescu, 1956; p. 1335, pl. 1, figs. 7–9 (Lower Eocene, France); Cytheridae.

Clithrocytheridea pusilla Apostolescu, 1956; p. 1335, pl. 1, figs. 13–14 (Lower Eocene, France); Cytheridae.

Cryptophyllus arsinius Stover, 1956; p. 1139, pl. 119, figs. 37–40 (Middle Devonian, New York); family uncertain.

Cypridea? alveata (Galeeva in litt.) Liubimova, 1956*c*; pp. 24–25, pl. 5, fig. 5a–b (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea accommodata Liubimova, 1956*c*; pp. 66–67, pl. 14, fig. 4a–c (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea copulenta Liubimova, 1956*c*; pp. 81–82, pl. 17, fig. 3a–b (Upper Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea? defluxa Liubimova, 1956*c*; pp. 60–61, pl. 13, fig. 2a–c (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea expedita Liubimova, 1956*c*; pp. 64–65, pl. 14, fig. 1a–c (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea fracta Liubimova, 1956*c*; pp. 83–84, pl. 17, fig. 2a–b (Upper Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea fundata Liubimova, 1956*c*; pp. 36–38, pl. 7, fig. 3a–c (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea justa Liubimova, 1956*c*; pp. 56–57, pl. 12, fig. 2a–b (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea mediocris (Galeeva in litt.) Liubimova, 1956*c*; pp. 52–53, pl. 11, fig. 1a–b (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea modica Liubimova, 1956*c*; pp. 73–75, pl. 16, fig. 3a–b (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea mundula Liubimova, 1956*c*; pp. 40–41, pl. 8, fig. 3a–c; pl. 9, fig. 1a–b (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea occullata Liubimova, 1956*c*; pp. 57–58, pl. 12, fig. 3a–c (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea odiosa Liubimova, 1956*c*; pp. 49–51, pl. 10, fig. 3a–b (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea priva Liubimova, 1956*c*; pp. 32–33, pl. 4, fig. 3a–c (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea profusa Liubimova, 1956*c*; pp. 80–81, pl. 17, fig. 4a–b (Upper Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea prognata Liubimova, 1956*c*; pp. 59–60, pl. 13, fig. 1a–b (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea punctilataeformis Liubimova, 1956*c*; pp. 47–48 (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea regia Liubimova, 1956*c*; pp. 75–76, pl. 16, fig. 1a–b (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea remota Liubimova, 1956*c*; pp. 30–31, pl. 4, fig. 2a–c (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea ruinosa Liubimova, 1956*c*; pp. 48–49, pl. 10, fig. 6a–c (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea sainschandaensis Liubimova, 1956*c*; pp. 71–72, pl. 16, fig. 4a–b (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea salva Liubimova, 1956*c*; pp. 72–73, pl. 16, fig. 2a–b (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea sinistroacuta Liubimova, 1956*c*; pp. 68–69, pl. 15, fig. 1a–c (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea spinigera Liubimova, 1956*c* (non Sowerby, 1836); pp. 55–56, pl. 12, fig. 1a–c (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea terminalis Liubimova, 1956*c*; pp. 84–85, pl. 18, fig. 1 (Upper Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea trapezoides (Galeeva in litt.) Liubimova, 1956*c*; p. 38, pl. 8, fig. 1a–c (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea trita Liubimova, 1956*c*; pp. 29–30, pl. 4, fig. 1a–c (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cypridea turitschevi Liubimova, 1956*c*; p. 54, pl. 11, fig. 3a–c (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Cyprideamorphella tarbagataiensis Mandelstam, in Mandelstam and others, 1956; p. 112, pl. 24, fig. 2, text-fig. 30 (Lower Cretaceous, Barremian, eastern Transbaikal); Cyprididae.

Cyprideis stenopora Triebel, 1956; p. 447, pl. 54, figs. 1–11; pl. 55, figs. 12–19; pl. 56, figs. 20–22 (Recent, Galapagos Islands); Cytherideinae.

"*Cythere*" *costata* Mertens, 1956 (non Brady, 1866); p. 190, pl. 9, figs. 27–30; pl. 10, figs. 31–32 (Lower Cretaceous, middle Albian, Germany); Cytheridae.

"*Cythere*" *favosa* Mertens, 1956; p. 189, pl. 9, figs. 23–26 (Lower Cretaceous, upper Albian, Germany); Cytheridae.

Cythere multipora Skinner, 1956; p. 190, pl. 2, fig. 4a–d (Upper Cretaceous, Arkansas); Cytheridae.

"*Cythere*" *semiconcentrica* Mertens, 1956; p. 186, pl. 9, figs. 15–18 (Lower Cretaceous, middle Albian, Germany); Cytheridae.

Cythere sigma Skinner, 1956; p. 191, pl. 3, fig. 1a–c (Upper Cretaceous, Arkansas); Cytheridae.

"*Cythere*" *steghausi* Mertens, 1956; p. 188, pl. 9, figs. 19–22 (Lower Cretaceous, upper Albian, Germany); Cytheridae.

Cythereis alata Hartmann, 1956*b*; pp. 39–43, text-figs. 53–63 (Recent, Brazil); Cytherinae.

Cythereis alexanderorum Skinner, 1956; p. 195, pl. 3, fig. 4a–c (Upper Cretaceous, Arkansas); Cytheridae.

Cythereis arbenzi Skinner, 1956; p. 195, pl. 4, fig. 10a–b (Upper Cretaceous, Arkansas); Cytheridae.

Cythereis cornueli Deroo, 1956; p. 1518, pl. 4, figs. 59–61 (Lower Cretaceous, France); Cytheridae.

Cythereis louvemontensis Deroo, 1956; p. 1517, pl. 4, figs. 56–57 (Lower Cretaceous, France); Cytheridae.

Cythereis pseudotuberata Apostolescu and Magné, 1956; p. 342, pl. 1, figs. 16–17 (Eocene, Algeria); Cytheridae, Trachyleberidinae.

Cythereis reticulata Hartmann, 1956*b*; pp. 36–39, text-figs. 45–52 (Recent, Brazil); Cytherinae.
Cytherella biplicata Liubimova, 1956*b*; p. 568, pl. 3, fig. 12 (Upper Jurassic, Ukraine); Cytherellidae.
Cytherella fornicata Apostolescu, 1956; p. 1332, pl. 1, figs. 1–2 (Lower Eocene, France); Cytherellidae.
Cytherelloidea cruciata Apostolescu, 1956; p. 1332, pl. 1, fig. 3 (Lower Eocene, France); Cytherellidae.
Cytherelloidea dalumensis Mertens, 1956; p. 180, pl. 8, figs. 1–3 (Lower Cretaceous, upper Albian, Germany); Cytherellidae.
Cytherelloidea pustulosa Apostolescu, 1956; p. 1333, pl. 1, fig. 4 (Lower Eocene, France); Cytherellidae.
Cytherella bernensis Oertli, 1956; p. 61, pl. 7, figs. 166–171, 173–176 (Oligocene, Switzerland); Cytheridae.
Cytheretta gutzwilleri Oertli, 1956; p. 64, pl. 8, figs. 189–192 (Oligocene, Switzerland); Cytheridae.
Cytheretta multicostata Apostolescu, 1956; p. 1340, pl. 2, figs. 32–33 (Lower Eocene, France); Cytheridae.
Cytheretta nerva Apostolescu, 1956; p. 1340, pl. 3, figs. 37–39 (Lower Eocene, France); Cytheridae.
Cytheretta triebeli Oertli, 1956; p. 63, pl. 7, figs. 177–179 (Oligocene, Switzerland); Cytheridae.
Cytheretta variabilis Oertli, 1956; p. 62, pl. 7, figs. 172, 180–188 (Oligocene, Switzerland); Cytheridae.
Cytheridea fallens Oertli, 1956; p. 36, pl. 2, figs. 42–49 (Oligocene, Switzerland); Cytheridae.
Cytheridea genavensis Oertli, 1956; p. 40, pl. 3, figs. 59–68 (Oligocene, Switzerland); Cytheridae.
Cytherissinella okrajantzi Schneider, 1956; p. 127, pl. 20, fig. 5 (Lower Triassic, Emba and Fergana, Russia); Cytheridae.
Cytheropterina vegranda Mandelstam, in Mandelstam and others, 1956; p. 133, pl. 24, fig. 5, text-fig. 45 (Upper Jurassic, Kimmeridgian, eastern Ukraine); Cytheridae.
Cytheropteron fossatum Skinner, 1956; p. 201, pl. 4, fig. 8 (Upper Cretaceous, Arkansas); Cytheridae.
Cytheropteron harrisi Skinner, 1956; p. 201, pl. 4, fig. 7 (Upper Cretaceous, Arkansas); Cytheridae.
Cytheropteron thiliensis Apostolescu, 1956; p. 1339, pl. 2, fig. 34 (Lower Eocene, France); Cytheridae.
Cytherura cancellea Hartmann, 1956*b*; pp. 43–46, text-figs. 64–71 (Recent, Brazil); Cytherurinae.
Darwinula absoluta Mandelstam, 1956; p. 78, pl. 12, figs. 15, 18–19 (Upper Permian, Siberia); Darwinulidae.
Darwinula abstrusa Mandelstam, 1956; p. 64, pl. 9, fig. 4 (Upper Permian, Siberia); Darwinulidae.
Darwinula acervalis Mandelstam, 1956; p. 76, pl. 12, figs. 3, 7–8 (Upper Permian, Siberia); Darwinulidae.
Darwinula aclinis Mandelstam, 1956; pp. 70–71, pl. 10, figs. 8–11 (Upper Permian, Siberia); Darwinulidae.
Darwinula adunctatis Mandelstam, 1956; pp. 71–72, pl. 10, figs. 14–15, 18 (Upper Permian, Siberia); Darwinulidae.
Darwinula altilis Mandelstam, 1956; p. 74, pl. 11, fig. 5 (Upper Permian, Siberia); Darwinulidae.
Darwinula apporecta Mandelstam, 1956; p. 75, pl. 11, fig. 8 (Upper Permian, Siberia); Darwinulidae.
Darwinula arta Liubimova, 1956*b*; p. 539, pl. 1, fig. 5a–b (Triassic, Ukraine); Darwinulidae.
Darwinula aservis Mandelstam, 1956; pp. 77–78, pl. 12, fig. 14 (Upper Permian, Siberia); Darwinulidae.
Darwinula attenta Mandelstam, 1956; p. 70, pl. 10, figs. 6–7 (Upper Permian, Siberia); Darwinulidae.
Darwinula beginga Mandelstam, 1956; p. 74, pl. 11, figs. 7, 9 (Upper Permian, Siberia); Darwinulidae.
Darwinula breviata Mandelstam, 1956; pp. 72–73, pl. 11, figs. 1–3 (Upper Permian, Siberia); Darwinulidae.
Darwinula clinata Mandelstam, 1956; p. 77, pl. 12, figs. 10, 13 (Upper Permian, Siberia); Darwinulidae.
Darwinula encelada Mandelstam, 1956; pp. 75–76, pl. 11, figs. 6, 11 (Upper Permian, Siberia); Darwinulidae.
Darwinula excussa Mandelstam, 1956; pp. 63–64, pl. 9, figs. 3, 6 (Upper Permian, Siberia); Darwinulidae.
Darwinula expolita Mandelstam, 1956; pp. 64–65, pl. 9, fig. 5 (Upper Permian, Siberia); Darwinulidae.
Darwinula frivolis Mandelstam, 1956; p. 72, pl. 10, fig. 17 (Upper Permian, Siberia); Darwinulidae.
Darwinula granumiformis Mandelstam, 1956; p. 77, pl. 12, figs. 9, 12 (Upper Permian, Siberia); Darwinulidae.
Darwinula impolita Mandelstam, 1956; p. 78, pl. 12, fig. 16 (Upper Permian, Siberia); Darwinulidae.
Darwinula impressa Mandelstam, 1956; pp. 62–63, pl. 9, fig. 1 (Upper Permian, Siberia); Darwinulidae.
Darwinula inervis Mandelstam, 1956; p. 65, pl. 9, figs. 8–9 (Upper Permian, Siberia); Darwinulidae.
Darwinula kedrovcaensis Mandelstam, 1956; p. 79, pl. 12, fig. 17 (Upper Permian, Siberia); Darwinulidae.
Darwinula modica Mandelstam, 1956; pp. 66–67, pl. 9, fig. 12 (Upper Permian, Siberia); Darwinulidae.
Darwinula monitoria Mandelstam, 1956; p. 69, pl. 10, figs. 1–4 (Upper Permian, Siberia); Darwinulidae.
Darwinula nana Mandelstam, 1956; p. 72, pl. 10, fig. 16; pl. 12, fig. 11 (Upper Permian, Siberia); Darwinulidae.
Darwinula nativa Mandelstam, 1956; pp. 69–70, pl. 10, fig. 5 (Upper Permian, Siberia); Darwinulidae.
Darwinula numirabilis Mandelstam, 1956; p. 71, pl. 10, fig. 13 (Upper Permian, Siberia); Darwinulidae.
Darwinula objecta Mandelstam, 1956; p. 66, pl. 9, figs. 10, 13; pl. 10, fig. 12 (Upper Permian, Siberia); Darwinulidae.
Darwinula oparia Mandelstam, 1956; p. 73, pl. 11, fig. 2 (Upper Permian, Siberia); Darwinulidae.
Darwinula operta Mandelstam, 1956; p. 68, pl. 9, fig. 17 (Upper Permian, Siberia); Darwinulidae.
Darwinula optimalis Mandelstam, 1956; pp. 65–66, pl. 9, fig. 11 (Upper Permian, Siberia); Darwinulidae.
Darwinula ordinata Mandelstam, 1956; p. 63, pl. 9, fig. 2 (Upper Permian, Siberia); Darwinulidae.
Darwinula ostenata Mandelstam, 1956; p. 67, pl. 9, fig. 14 (Upper Permian, Siberia); Darwinulidae.
Darwinula promissa Liubimova, 1956*b*; p. 541, pl. 1, fig. 7a–b (Triassic, Ukraine); Darwinulidae.
Darwinula prospexa Mandelstam, 1956; p. 68, pl. 9, fig. 16 (Upper Permian, Siberia); Darwinulidae.
Darwinula reflexibilis Mandelstam, 1956; pp. 73–74, pl. 11, figs. 4, 6 (Upper Permian, Siberia); Darwinulidae.
Darwinula rotundata Liubimova, 1956*b*; p. 540, pl. 1, fig. 6a–b (Triassic, Ukraine); Darwinulidae.

Darwinula stricta Mandelstam, 1956; p. 67, pl. 9, fig. 15a–b (Upper Permian, Siberia); Darwinulidae.

Darwinula testata Mandelstam, 1956; p. 76, pl. 12, figs. 1, 2a–b (Upper Permian, Siberia); Darwinulidae.

Darwinula tubiformis Liubimova, 1956*c*; pp. 119–120, pl. 23, fig. 1a–b (Lower Cretaceous, Mongolia); Darwinulidae.

Darwinula umbratica Mandelstam, 1956; p. 69, pl. 9, fig. 18 (Upper Permian, Siberia); Darwinulidae.

Darwinula uscatensis Mandelstam, 1956; p. 75, pl. 11, fig. 10a–b (Upper Permian, Siberia); Darwinulidae.

Darwinuloides circulosa Mandelstam, 1956; pp. 79–80, pl. 9, fig. 19; pl. 11, fig. 12 (Upper Permian, Siberia); Darwinulidae.

Darwinuloides grata Mandelstam, 1956; p. 80, pl. 9, fig. 20 (Upper Permian, Siberia); Darwinulidae.

Darwinuloides ingenuata Mandelstam, 1956; pp. 80–81, pl. 11, fig. 13 (Upper Permian, Siberia); Darwinulidae.

Dibolbina macrosculata Swartz and Whitmore, 1956; p. 1061, pl. 104, fig. 10 (Upper Silurian, New Jersey); Beyrichiidae.

Dictyocythere (*Dictyocythere*) *mediostricta* Sylvester-Bradley, 1956; p. 16, pl. 3, figs. 2–6 (Upper Jurassic, England); family uncertain.

Dizygopleura angustisulcata Swartz and Whitmore, 1956; p. 1086, pl. 109, figs. 22–25 (Upper Silurian, New Jersey); Kloedenellidae.

Dolocythere rara Mertens, 1956; p. 192, pl. 10, figs. 33–37; pl. 13, figs. 91–93 (Lower Cretaceous, lower Albian, Germany); Cytheridae.

Dolocytheridea solita Liubimova, 1956*b*; p. 567, pl. 3, fig. 11 (Upper Jurassic, Ukraine); Cytheridae.

Doraclatum compandium Stover, 1956; p. 1136, pl. 119, figs. 1–5 (Middle Devonian, New York); family uncertain.

Emphasia ceratophaga Mandelstam, in Mandelstam and others, 1956; p. 129, pl. 23, fig. 2, text-fig. 41 (Middle Jurassic, Kazakhstan, Russia); Cytheridae.

Eocytheropteron bruggenense Oertli, 1956; p. 74, pl. 9, figs. 253–257 (Miocene, Switzerland); Cytheridae.

Eucytherura quadrituberculata Skinner, 1956; p. 202, pl. 4, fig. 11 (Upper Cretaceous, Arkansas); Cytheridae.

Eucytherura signata Mandelstam, in Mandelstam and others, 1956; p. 134, pl. 24, fig. 7, text-fig. 46 (Paleogene to Quaternary, eastern Ukraine); Cytheridae.

Euglyphella aspapha Stover, 1956; p. 1128, pl. 118, figs. 17–18, text-fig. 2 (Middle Devonian, New York); Quasillitidae.

Euglyphella deltella Stover, 1956; p. 1130, pl. 118, figs. 19–23, text-figs. 3–5 (Middle Devonian, New York); Quasillitidae.

Eukloedenella cicatrix Swartz and Whitmore, 1956; p. 1083, pl. 109, figs. 1–3 (Upper Silurian, New Jersey); Kloedenellidae.

Eukloedenella manliensis Swartz and Whitmore, 1956; p. 1083, pl. 109, figs. 4–6 (Upper Silurian, New Jersey); Kloedenellidae.

Exuocypris extorris Mandelstam, in Mandelstam and others, 1956; p. 115, text-figs. 33–34 (Middle Pliocene, western Turkmenia, Russia); Cyprididae.

Fabalicypris illustris Schneider, 1956; p. 93, pl. 21, fig. 5 (Lower Carboniferous, Tournaisian, Middle Pechora, Russian Platform); Bairdiidae.

Falsipollex simplilobatus Stover, 1956; p. 1102, pl. 112, figs. 1–3 (Middle Devonian, New York); Hollinidae.

Franklinella? curvata Kupfahl, 1956; p. 24, pl. 4, fig. 7 (Upper Devonian, Germany).

Gemmanella schweyeri Schneider, 1956; p. 123, pl. 19, fig. 1 (Lower Triassic, Emba); Cytheridae.

Glorianella efforta Glebovskaia, 1956; p. 122, pl. 19, fig. 4, text-fig. 39 (Lower Triassic, Emba); Cytheridae.

Glyptopleura campaui Crane and Kelly, 1956; p. 871, pl. 98, fig. 2 (Middle Mississippian, Meramecian, Michigan); Glyptopleuridae.

Glyptopleura cuneata Crane and Kelly, 1956; p. 870, pl. 98, fig. 1 (Middle Mississippian, Meramecian, Michigan); Glyptopleuridae.

Glyptopleura omerensis Crane and Kelly, 1956; p. 870, pl. 98, fig. 5 (Middle Mississippian, Meramecian, Michigan); Glyptopleuridae.

Gubkiniella miranda Kuznetsova, 1956; p. 143, pl. 24, fig. 3 (Lower Cretaceous, Barremian, southeastern Caucasus); Cytheridae.

Haplocytheridea subalpina Oertli, 1956; p. 46, pl. 4, figs. 105–109 (Oligocene, Switzerland); Cytheridae.

Hemicythere? triangularis Oertli, 1956; p. 95, pl. 13, figs. 348–354 (Miocene, Switzerland); Trachyleberididae.

Hollinella ampulla Stover, 1956; p. 1101, pl. 111, fig. 12 (Middle Devonian, New York); Hollinidae.

Hollinella epakra Stover, 1956; p. 1100, pl. 111, figs. 9–11 (Middle Devonian, New York); Hollinidae.

Hollinella retusilobata Stover, 1956; p. 1099, pl. 111, figs. 7–8 (Middle Devonian, New York); Hollinidae.

Hollinella sella Stover, 1956; p. 1096, pl. 111, figs. 1–6 (Middle Devonian, New York); Hollinidae.

Howella echinata Puri, 1956 (generic name preoccupied by *Howella* Ogilby, 1899); p. 275, pl. 35, figs. 9–14; pl. 36, figs. 1–4 (Upper Eocene, Florida); Trachyleberinae.

Hutsonia nalivkini Liubimova, 1956*b*; p. 563, pl. 3, fig. 6a–b (Upper Jurassic, Ukraine); Cytheridae.

Ilyocyprimorpha palustris Mandelstam, in Mandelstam and others, 1956; p. 111, pl. 24, fig. 1, text-fig. 29 (Lower Cretaceous, southern part of eastern Transbaikal); Cyprididae.

Iniella abunda Mandelstam, 1956; p. 100, pl. 13, fig. 2 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Iniella testata Mandelstam, 1956; pp. 100–101, pl. 13, figs. 3, 6 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Jonesina apoglypha Stover, 1956; p. 1111, pl. 114, figs. 26–29 (Middle Devonian, New York); Kloedenellidae.

Kassinia kassini Mandelstam, in Mandelstam and others, 1956 (generic name preoccupied by *Kassinia* Khabakov, 1937); p. 119, pl. 23, fig. 4, text-fig. 38 (Middle Oligocene, Kazakhstan, Russia); Cyprididae.

Kemeroviana advena Mandelstam, 1956; pp. 98–99, pl. 19, fig. 9 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Kemeroviana argulata Mandelstam, 1956; p. 97, pl. 19, fig. 1 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Kemeroviana ellipsoidea Mandelstam, 1956; p. 98, pl. 19, figs. 3–5 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Kemeroviana striata Mandelstam, 1956; pp. 97–98, pl. 19, fig. 2 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Kirkbyella tora Stover, 1956; p. 1133, pl. 119, figs. 17–22 (Middle Devonian, New York); family uncertain.

Kloedenella bipustulata Swartz and Whitmore, 1956; p. 1083, pl. 109, figs. 7–15 (Upper Silurian, New York and New Jersey); Kloedenellidae.

Kloedenella parvisulcata Swartz and Whitmore, 1956; p. 1085, pl. 109, figs. 16–21 (Upper Silurian, New Jersey); Kloedenellidae.

Kloedenia aparchoides Swartz and Whitmore, 1956; p. 1067, pl. 103, figs. 11–14 (Upper Silurian, New York and New Jersey); Zygobolbidae.

Kloedenia crassipunctata Swartz and Whitmore, 1956; p. 1065, pl. 106, figs. 16–18 (Upper Silurian, New York and New Jersey); Zygobolbidae.

Kloedenia duplicipunctata Swartz and Whitmore, 1956; p. 1065, pl. 106, figs. 13–15 (Upper Silurian, New York and New Jersey); Zygobolbidae.

Leguminocythereis cirtaensis Apostolescu and Magné, 1956; p. 339, pl. 1, figs. 1–2 (Eocene, Algeria); Cytheridae, Cytherinae.

Leguminocythereis lienenklausi Oertli, 1956; p. 93, pl. 13, figs. 342–347 (Oligocene, Switzerland); Trachyleberididae.

Leguminocythereis numidica Apostolescu and Magné, 1956; p. 339, pl. 1, figs. 3–4 (Eocene, Algeria); Cytheridae, Cytherinae.

Leguminocythereis sorneana Oertli, 1956; p. 91, pl. 12, figs. 320–337 (Oligocene, Switzerland); Trachyleberididae.

Leiocyamus apicatus Martinsson, 1956; p. 30, pls. 4–5, figs. 38–42 (Middle Silurian, Sweden); Primitiopsidae, Leiocyaminae.

Leptocythere costata Hartmann, 1956*b*; pp. 22–26, text-figs. 9–15 (Recent, Brazil); Cytherinae.

Leptocythere ornata Hartmann, 1956*b*; pp. 20–22, text-figs. 1–8 (Recent, Brazil); Cytherinae.

Limbinaria biangulata Swartz and Whitmore, 1956; p. 1057, pl. 110, figs. 7–9 (Upper Silurian, New Jersey); Primitiopsidae.

Limbinaria multipunctata Swartz, 1956; p. 1056, text-fig. 4a–b (Upper Silurian, Virginia and Tennessee); Primitiopsidae.

Limbinaria paucipunctata Swartz and Whitmore, 1956; p. 1057, pl. 103, figs. 9–10 (Upper Silurian, New Jersey); Primitiopsidae.

Limnocypridea abscondida Liubimova, 1956*a*; p. 108, pl. 26, fig. 2, text-fig. 27 (Lower Cretaceous, Mongolia); Cyprididae. (This species was published as new both in this paper and in the following paper.)

Limnocypridea abscondida Liubimova, 1956*c*; pp. 12–13, pl. 1, fig. 2a–c (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae. (See the preceding entry.)

Limnocypridea bitumulosa Liubimova, 1956*c*; pp. 15–16, pl. 3, fig. 1a–b (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Limnocypridea grammi Liubimova, 1956*c*; pp. 16–17, pl. 3, figs. 2a–c, 3a–b (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Limnocypridea subplana Liubimova, 1956*c*; pp. 10–11, pl. 1, fig. 1a–b (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Limnocypridea tumulosa Liubimova, 1956*c*; pp. 13–14, pl. 2, figs. 1a–c, 2a–c (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Lophokloedenia eufimbriata Swartz and Whitmore, 1956; p. 1071, pl. 107, figs. 14–18 (Upper Silurian, New York); Zygobolbidae.

Loxoconcha bullata Hartmann, 1956*b*; pp. 49–52, text-figs. 79–87 (Recent, Brazil); Loxoconchinae.

Loxoconcha? cavernosa Apostolescu and Magné, 1956; p. 340, pl. 1, figs. 7–9 (Eocene, Algeria); Cytheridae, Loxoconchinae.

Loxoconcha delemontensis Oertli, 1956; p. 68, pl. 8, figs. 211–219 (Oligocene, Switzerland); Cytheridae.

Loxoconcha foveata Hartmann, 1956*b*; pp. 46–49, text-figs. 72–78 (Recent, Brazil); Loxoconchinae.

Loxoconcha gounodensis Apostolescu and Magné, 1956; p. 340, pl. 1, figs. 5–6 (Eocene, Algeria); Cytheridae, Loxoconchinae.

Loxoconcha polita Apostolescu and Magné, 1956; p. 341, pl. 1, figs. 12–13 (Eocene, Algeria); Cytheridae, Loxoconchinae.

Loxoconcha? semipunctata Apostolescu and Magné, 1956; p. 342, pl. 1, figs. 10–11 (Eocene, Algeria); Cytheridae, Loxoconchinae.

Loxoconcha semirugosa Apostolescu and Magné, 1956; p. 341, pl. 1, figs. 14–15 (Eocene, Algeria); Cytheridae, Loxoconchinae.

Lutkevichinella bruttanae Schneider, 1956; p. 126, pl. 19, fig. 2, text-fig. 40 (Lower Triassic, Emba); Cytheridae.

Lycopterocypris? celsa Liubimova, 1956*c*; pp. 112–113; pl. 21, fig. 9a–b (Upper Cretaceous, Mongolia); Cyprididae, Cypridinae.

Lycopterocypris circulata Liubimova, 1956*c*; pp. 105–106, pl. 21, fig. 4a–c (Lower Cretaceous, Mongolia); Cyprididae, Cypridinae.

Lycopterocypris contrita Liubimova, 1956*c*; pp. 115–116, pl. 22, fig. 6a–c (Upper Cretaceous, Mongolia); Cyprididae, Cypridinae.

Lycopterocypris debilis Liubimova, 1956*c*; pp. 107–108, pl. 21, fig. 5a–c (Lower Cretaceous, Mongolia); Cyprididae, Cypridinae.

Lycopterocypris eggeri Mandelstam, in Mandelstam and others, 1956; p. 116, text-figs. 35–37 (Lower Cretaceous, eastern Transbaikal, Siberia and Mongolia); Cyprididae.

Lycopterocypris fabaeformis Galeeva, 1956, in Liubimova, 1956*c*; pp. 111–112, pl. 21, fig. 8a–b (Upper Cretaceous, Mongolia); Cypridinae.

Lycopterocypris infantilis Liubimova, 1956*c*; pp. 106–107, pl. 21, figs. 1a–b, 2a–b, 3a–b (Lower Cretaceous, Mongolia); Cyprididae, Cypridinae.

Lycopterocypris ingloria Liubimova, 1956*c*; pp. 109–110, pl. 22, fig. 4a–b (Lower Cretaceous, Mongolia); Cyprididae, Cypridinae.

Lycopterocypris? multifera Liubimova, 1956*c*; pp. 108–109, pl. 21, figs. 6a–c, 7a–b (Lower Cretaceous, Mongolia); Cyprididae, Cypridinae.

Lycopterocypris profunda Liubimova, 1956*c*; pp. 113–114, pl. 22, fig. 5a–b (Upper Cretaceous, Mongolia); Cyprididae, Cypridinae.

Mandelstamia facilis Liubimova, 1956*a*; p. 142, pl. 26, fig. 3, text-fig. 53 (Upper Jurassic, Volga region); Cytheridae.

Mediocypris brodi Schneider, 1956; p. 97, pl. 21, fig. 1, text-fig. 19 (Middle Miocene, Chokrakian, northern Ossetia, Caucasus); Cyprididae.

Menoeidina multipunctata Stover, 1956; p. 1116, pl. 114, figs. 11–14 (Middle Devonian, New York); Cytherellidae.

Menoeidina versicula Stover, 1956; p. 1115, pl. 114, figs. 15–19 (Middle Devonian, New York); Cytherellidae.

Mesocythere elongata Hartmann, 1956*c*; pp. 31–33, text-figs. 28–35 (Recent, Brazil); Cytherinae.

Mesocythere foveata Hartmann, 1956*c*; pp. 28–31, text-figs. 19–27 (Recent, Brazil); Cytherinae.

Mesomphalus rhomboidalis Swartz and Whitmore, 1956; p. 1077, pl. 105, figs. 1–4 (Upper Silurian, New Jersey); Zygobolbidae.

Mesomphalus striatellus Swartz and Whitmore, 1956; p. 1078, pl. 105, figs. 5–7 (Upper Silurian, New York); Zygobolbidae.

Microcytherura boulangei Rome, 1956; p. 4, text-figs. 1–2 (Recent, France); Cytheridae.

Mongolianella? adulata Liubimova, 1956*c*; pp. 91–92, pl. 19, fig. 3a–b (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Mongolianella khamariniensis Galeeva (in litt.) in Liubimova, 1956*c*; pp. 89–90, pl. 19, fig. 1a–b (Lower Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Mongolianella ordinata Liubimova, 1956*c*; pp. 90–91, pl. 19, fig. 2a–c (Upper Cretaceous, Mongolia); Cyprididae, Cyprideinae.

Mongolianella palmosa Mandelstam, in Mandelstam and others, 1956; p. 113, pl. 23, fig. 5, text-fig. 31 (Lower Cretaceous, Barremian, southeastern Transbaikal and Mongolia); Cyprididae.

Monoceratina postnodosa Harris and Jobe, 1956; p. 8, pl. 2, fig. 1a–b (Upper Mississippian, Oklahoma); Acronotellidae.

Myomphalus dorsinodosus Swartz and Whitmore, 1956; p. 1074, pl. 103, figs. 15–17 (Upper Silurian, New York and New Jersey); Zygobolbidae.

Neocyprideis durocortoriensis Apostolescu, 1956; p. 1338, pl. 2, figs. 19–22; pl. 4, figs. 57–61 (Lower Eocene, France); Cytheridae.

Neocythere vanveeni Mertens, 1956; p. 205, pl. 12, figs. 73–78; pl. 14, figs. 100–102 (Upper Cretaceous, upper Albian, Germany); Cytheridae, Progonocytherinae. (The ending of the specific name should be "*-ae*," to read "*vanveenae*.")

Octonaria bifurcata Stover, 1956; p. 1118, pl. 115, figs. 7–9, text-fig. 1 (Middle Devonian, New York); Thlipsuridae.

Origoilyocypris aspera Liubimova, 1956*c*; pp. 100–102, pl. 20, fig. 7a–b (Upper Cretaceous, Mongolia); Cyprididae, Ilyocypridinae.

Origoilyocypris barunbainensis Liubimova, 1956*c*; pp. 95–96, pl. 20, fig. 2a–b (Lower Cretaceous, Mongolia); Cyprididae, Ilyocypridinae.

Origoilyocypris cirrita Mandelstam, in Mandelstam and others, 1956; p. 110, pl. 24, fig. 4, text-fig. 28 (Lower Cretaceous, Dzhungaria, Russia); Cyprididae.

Origoilyocypris panosa Liubimova, 1956*c*; pp. 98–99, pl. 20, fig. 5a–b (Upper Cretaceous, Mongolia); Cyprididae, Ilyocypridinae.

Origoilyocypris sortilega Liubimova, 1956*c*; pp. 99–100, pl. 20, fig. 6a–b (Lower and Upper Cretaceous, Mongolia); Cyprididae, Ilyocypridinae.

Origoilyocypris tugurigensis Liubimova, 1956*c*; pp. 97–98, pl. 20, fig. 4a–b (Lower Cretaceous, Mongolia); Cyprididae, Ilyocypridinae.

Palaeocytheridea arcessita Liubimova, 1956*b*; p. 555, pl. 2, fig. 9 (Upper Jurassic, Ukraine); Cytheridae.

Palaeocytheridea cibaria Liubimova, 1956*b*; p. 562, pl. 3, fig. 5a–b (Upper Jurassic, Ukraine); Cytheridae.

Palaeocytheridea contracta Liubimova, 1956*b*; p. 560, pl. 3, fig. 3 (Upper Jurassic, Ukraine); Cytheridae.

Palaeocytheridea cultis Liubimova, 1956*b*; p. 559, pl. 3, fig. 1 (Upper Jurassic, Ukraine); Cytheridae.

Palaeocytheridea globosa Liubimova, 1956*b*; p. 558, pl. 2, fig. 15 (Upper Jurassic, Ukraine); Cytheridae.

Palaeocytheridea grigorievi Liubimova, 1956*b*; p. 561, pl. 3, fig. 4 (Upper Jurassic, Ukraine); Cytheridae.

Palaeocytheridea kamenkaensis Liubimova, 1956*b*; p. 557, pl. 2, fig. 14 (Upper Jurassic, Ukraine); Cytheridae.

Palaeocytheridea kowalewskyi Liubimova, 1956*b*; p. 559, pl. 3, fig. 2 (Upper Jurassic, Ukraine); Cytheridae.

Palaeocytheridea reticulata Liubimova, 1956*b*; p. 554, pl. 2, fig. 12 (Upper Jurassic, Ukraine); Cytheridae.

Palaeocytheridea sudorocostata Liubimova, 1956*b*; p. 553, pl. 2, fig. 11 (Upper Jurassic, Ukraine); Cytheridae.

Paleomonsmirabilia paupera Apostolescu, 1956; p. 1339, pl. 2, figs. 30–31; pl. 4, figs. 62–63 (Lower Eocene, France); Cytheridae.

Parabolbina cuneospinosa Swartz and Whitmore, 1956; p. 1058, pl. 110, figs. 1–6 (Upper Silurian, New York and New Jersey); Hollinidae.

Parabufina convexa Smith, 1956; p. 7, pl. 1, figs. 16–18 (Middle Devonian, New York); Ropolonellidae.

Parabufina postruncata Smith, 1956; p. 7, pl. 1, fig. 19 (Middle Devonian, New York); Ropolonellidae.

Paracavellina elliptica var. *manningensis* Harris and Jobe, 1956, n. var.; p. 22, pl. 4, figs. 16, 17a–c (Upper Mississippian, Oklahoma); Cytherellidae.

Paracypris aerodynamica Oertli, 1956; p. 32, pl. 1, figs. 24–26, 28–30 (Oligocene, Switzerland); Cyprididae.

Paracypris makridini Liubimova, 1956*b*; p. 537, pl. 1, fig. 4 (Upper Jurassic, Ukraine); Cyprididae.

Paracypris stripta Liubimova, 1956*b*; p. 537, pl. 1, fig. 3 (Upper Jurassic, Ukraine); Cyprididae.

Paradoxostoma fornicatum Hartmann, 1956*b*; pp. 57–59, text-figs. 99–105 (Recent, Brazil); Paradoxostominae.

Paradoxostoma ilhabelae Hartmann, 1956*b*; pp. 59–61, text-figs. 106–111 (Recent, Brazil); Paradoxostominae.

Parahealdia? convexoris Swartz and Whitmore, 1956; p. 1089, pl. 110, figs. 17–19 (Upper Silurian, New Jersey); Healdiidae.

Paraparchites asymmetricus Stover, 1956; p. 1132, pl. 116, figs. 8–11 (Middle Devonian, New York); Leperditellidae.

Paraparchites manningensis Harris and Jobe, 1956; p. 5, pl. 1, fig. 5a–d (Upper Mississippian, Oklahoma); Aparchitidae.

Paraparchites projectus Harris and Jobe, 1956; p. 6, pl. 1, figs. 6, 7a–d (Upper Mississippian, Oklahoma); Aparchitidae.

Paraparchites veberi Mandelstam, 1956; p. 102, pl. 19, figs. 6–7 (Lower Permian, Siberia); Leperditellidae.

Parataxodonta uralensis Mandelstam, in Mandelstam and others, 1956; p. 137, pl. 23, fig. 1, text-fig. 49 (Lower Cretaceous, Aptian and Albian, Kazakhstan (Uralsk region), and Mangyshlak Peninsula); Cytheridae.

Perissocytheridea fredericensis Apostolescu, 1956; p. 1336, pl. 2, figs. 25–26 (Lower Eocene, France); Cytheridae.

Perprimitia arenacensis Crane and Kelly, 1956; p. 872, pl. 98, fig. 11 (Middle Mississippian, Meramecian, Michigan); Kloedenellidae.

Perprimitia rhomboidea Crane and Kelly, 1956; p. 872, pl. 98, fig. 6 (Middle Mississippian, Meramecian, Michigan); Kloedenellidae.

Phlyctiscapha subovata Smith, 1956; p. 4, pl. 1, figs. 1–3 (Middle Devonian, New York); Beyrichiidae.

Platycythereis triebeli Mertens, 1956; p. 211, pl. 12, figs. 86–88 (Lower Cretaceous, middle Albian, Germany); Trachyleberididae.

Pleurocythere explicata Liubimova, 1956*b*; p. 546, pl. 2, fig. 4 (Upper Jurassic, Ukraine); Cytheridae.

Pleurocythere juvenes Liubimova, 1956*b*; p. 547, pl. 2, fig. 3 (Upper Jurassic, Ukraine); Cytheridae.

Pokornyella calix Oertli, 1956; p. 100, pl. 14, figs. 379–386 (Oligocene, Switzerland); Trachyleberididae.

Polytylites lobatus Harris and Jobe, 1956; p. 14, pl. 3, fig. 3 (Upper Mississippian, Oklahoma); Kirkbyidae.

Pontocyprella izjumica Liubimova, 1956*b*; p. 536, pl. 1, fig. 2 (Upper Jurassic, Ukraine); Cyprididae.

Pontocyprella vescusa Liubimova, 1956*b*; p. 535, pl. 1, fig. 1 (Upper Jurassic, Ukraine); Cyprididae.

Pontocythere therwilensis Oertli, 1956; p. 57, pl. 6, figs. 152–155 (Oligocene, Switzerland); Cytheridae.

Progonocythere memorabilis Liubimova, 1956*b*; p. 550, pl. 2, fig. 8a–b (Upper Jurassic, Ukraine); Cytheridae.

Prosopeionum plexum Stover, 1956; p. 1123, pl. 116, figs. 31–37 (Middle Devonian, New York); Quasillitidae.

Protocythere kremenecensis Liubimova, 1956*b*; p. 552, pl. 2, fig. 7 (Upper Jurassic, Ukraine); Cytheridae.

Pseudobeyrichia perornata Swartz and Whitmore, 1956; p. 1062, pl. 104, figs. 11–12 (Upper Silurian, New Jersey); Beyrichiidae.

Pseudobythocythere goerlichi Mertens, 1956; p. 201, pl. 11, figs. 62–65; pl. 13, figs. 94–96 (Lower Cretaceous, lower Albian, Germany); Cytheridae, Bythocytherinae.

Pseudoleperditia tuberculifera Schneider, 1956; p. 87, pl. 22, fig. 1 (Lower Carboniferous, Tournaisian, northeastern part of the Russian Platform); Primitiidae.

Pterygocythereis helvetica Oertli, 1956; p. 87, pl. 11, fig. 310; pl. 16, figs. 404–406 (Oligocene, Switzerland); Trachyleberididae.

Pterygocythereis retinodosa Oertli, 1956; p. 83, pl. 11, figs. 291–298, 307; pl. 15, figs. 397–398; pl. 16, fig. 410 (Oligocene, Switzerland); Trachyleberididae.

Pterygocythereis volans Oertli, 1956; p. 85, pl. 11, figs. 306, 308; pl. 15, figs. 399–401 (Oligocene, Switzerland); Trachyleberididae.

Puriana canaliculata Apostolescu, 1956; p. 1341, pl. 3, figs. 43–44 (Lower Eocene, France); Trachyleberididae.

Puriana sculpta Apostolescu, 1956; p. 1342, pl. 3, figs. 49–50 (Lower Eocene, France); Trachyleberididae.

Pyrocytheridea pergraphica Liubimova, 1956*a*; p. 140, pl. 26, fig. 1, text-fig. 52 (Upper Jurassic, Callovian, Middle Volga, Samara region); Cytheridae.

Quasillites angulatus Smith, 1956; p. 6, pl. 1, figs. 12–15 (Middle Devonian, New York); Graphiadactyllidae.

Richina selenicristata Stover, 1956; p. 1108, pl. 113, figs. 7–9 (Middle Devonian, New York); Drepanellidae.

Richina zygalis Swartz and Whitmore, 1956; p. 1058, pl. 103, figs. 7–8 (Upper Silurian, New York); Drepanellidae.

Robsoniella obovata Kuznetsova, 1956; p. 120, pl. 27, figs. 1–3 (Lower Cretaceous, Aptian, southeastern Caucasus); Cyprididae.

Roundyella? concentrica Stover, 1956; p. 1138, pl. 119, figs. 13–16 (Middle Devonian, New York); family uncertain.

Saccarchites saccularis Swartz and Whitmore, 1956; p. 1080, pl. 103, figs. 18–19 (Upper Silurian, New York and New Jersey); Zygobolbidae.

Scalptina incuda Stover, 1956; p. 1123, pl. 116, figs. 27–30 (Middle Devonian, New York); Quasillitidae.

Scherochilus ventriosus Hartmann, 1956*b*; pp. 52–56, text-figs. 88–98 (Recent, Brazil); Paradoxostominae.

Schizocythere picta Apostolescu, 1956; p. 1339, pl. 2, figs. 35–36 (Lower Eocene, France); Cytheridae.

Schuleridea rauracica Oertli, 1956; p. 47, pl. 5, figs. 110–123 (Oligocene, Switzerland); Cytheridae.

Speluncella spinosa Schneider, 1956; p. 121, pl. 19, fig. 3 (Lower Triassic, Emba); Cytheridae.

Strepulites divectus Stover, 1956; p. 1117, pl. 115, figs. 4–6 (Middle Devonian, New York); Thlipsuridae.

Subligaculum aculeatum Stover, 1956; p. 1107, pl. 111, figs. 18–20 (Middle Devonian, New York); Hollinidae.

Sulcella emicatusa Stover, 1956; p. 1114, pl. 114, figs. 7–8 (Middle Devonian, New York); Cytherellidae.

Suzinia transcaucasica Suzin, 1956; p. 101, pl. 22, figs. 2–3, text-fig. 22 (Lower Oligocene, Armenia); Cyprididae.

Tetrasacculus paeneteichus Stover, 1956; p. 1106, pl. 113, figs. 1–6 (Middle Devonian, New York); Hollinidae.

Theriosynecum difensorum Mandelstam, in Mandelstam and others, 1956; p. 139, pl. 26, fig. 5 (Lower Cretaceous, Barremian, eastern Transbaikal); Cytheridae.

Theriosynecum defensum Liubimova, 1956*c*; pp. 141–142, pl. 25, fig. 4a–c (Lower Cretaceous, Mongolia); Cytheridae.

Theriosynecum kristaphovitshi Mandelstam, in Mandelstam and others, 1956; p. 138, text-fig. 51 (Lower Cretaceous, eastern Transbaikal, Fergana and Mongolia); Cytheridae. (See also Liubimova, 1956*b*, p. 137.)

Theriosynecum praetuberculata Liubimova, 1956*c*; pp. 139–140, pl. 25, figs. 1a–c, 2a–c, 3a–b (Lower Cretaceous, Mongolia); Cytheridae.

Thlipsuropsis digitata Swartz and Whitmore, 1956; p. 1088, pl. 110, fig. 16 (Upper Silurian, New Jersey); Thlipsuridae.

Thlipsuropsis diploglyptulis Swartz and Whitmore, 1956; p. 1087, pl. 110, figs. 10–12 (Upper Silurian, New York and New Jersey); Thlipsuridae.

Thlipsuropsis longisulcata Swartz and Whitmore, 1956; p. 1088, pl. 110, figs. 14–15 (Upper Silurian, New Jersey); Thlipsuridae.

Timiriasevia bicornis Galeeva (in litt.), in Liubimova, 1956*c*; pp. 126–128, pl. 23, fig. 6a–c (Lower Cretaceous, Mongolia); Cytheridae.

Timiriasevia fluxalis Liubimova, 1956*c*; pp. 133–134, pl. 24, fig. 3a–b (Upper Cretaceous, Mongolia); Cytheridae.

Timiriasevia grata Liubimova, 1956*c*; pp. 131–133, pl. 24, fig. 6a–b (Upper Cretaceous, Mongolia); Cytheridae.

Timiriasevia principalis Liubimova, 1956*c*; pp. 129–130, pl. 24, fig. 1a–b (Upper Cretaceous, Mongolia); Cytheridae.

Timiriasevia versabilis Mandelstam, 1956, in Liubimova, 1956*c*; pp. 122–123, pl. 23, fig. 5a–b (Lower Cretaceous, Mongolia); Cytheridae.

Tomiella accurata Mandelstam, 1956; pp. 87–88, pl. 15, fig. 5 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Tomiella arenosa Mandelstam, 1956; p. 88, pl. 15, fig. 3 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Tomiella arta Mandelstam, 1956; pp. 90–91, pl. 18, figs. 1–4 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Tomiella atenta Mandelstam, 1956; p. 89, pl. 14, fig. 5 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Tomiella beata Mandelstam, 1956; p. 88, pl. 14, fig. 4 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Tomiella borisovkaensis Mandelstam, 1956; p. 94, pl. 16, figs. 9–10 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Tomiella cicatricosa Mandelstam, 1956; p. 91, pl. 17, figs. 1, 7; pl. 16, fig. 1; pl. 18, figs. 7, 8 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Tomiella contracta Mandelstam, 1956; pp. 91–92, pl. 17, fig. 17 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Tomiella fistulosa Mandelstam, 1956; p. 90, pl. 14, fig. 12; pl. 16, fig. 5 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Tomiella incondita Mandelstam, 1956; p. 93, pl. 17, figs. 13, 15–16 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Tomiella khalfini Mandelstam, 1956; pp. 89–90, pl. 14, figs. 10–11, 13 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Tomiella marczenkoi Mandelstam, 1956; pp. 94–95, pl. 16, fig. 6 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Tomiella markinaensis Mandelstam, 1956; pp. 93–94, pl. 16, fig. 8 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Tomiella onulata Mandelstam, 1956; p. 92, pl. 16, figs. 2–3 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Tomiella suriekovaensis Mandelstam, 1956; pp. 92–93, pl. 16, figs. 4, 7; pl. 18, fig. 10 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Tomiellina inerrantis Mandelstam, 1956; p. 96, pl. 18, figs. 9, 11–12 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Tomiellina umbrata Mandelstam, 1956; pp. 95–96, pl. 18, fig. 6 (Upper Permian, Siberia); Cytheridae, Tomiellinae.

Triassinella chramovi Schneider, 1956; p. 124, pl. 22, fig. 7 (Lower Triassic, Emba); Cytheridae.

Triemilomatella prisca Jaanusson and Martinsson, 1956; p. 404, pl. 1, figs. 1–6 (Middle Silurian, Sweden); Ctenoloculininae.

Triginglymus comendiensis Apostolescu, 1956; p. 1342, pl. 3, figs. 45–46; pl. 4, figs. 64–65 (Lower Eocene, France); Trachyleberididae.

Triginglymus cribratus Apostolescu, 1956; p. 1343, pl. 3, figs. 47–48 (Lower Eocene, France); Trachyleberididae.

Ulrichia ventura Stover, 1956; p. 1109, pl. 113, figs. 23–25 (Middle Devonian, New York); Drepanellidae.

Ussuriocypris ussurica Mandelstam, in Mandelstam and others, 1956; p. 118, pl. 25, figs. 11–13 (Lower Cretaceous, Ussurian Bay, Far East); Cyprididae.

Velibeyrichia paucigranulosa Swartz and Whitmore, 1956; p. 1060, pl. 104, figs. 4–9 (Upper Silurian, New Jersey); Beyrichiidae.

Velibeyrichia reticulosaccula Swartz and Whitmore, 1956; p. 1059, pl. 104, figs. 1–3 (Upper Silurian, New York and New Jersey); Beyrichiidae.

Vetustocytheridea quitrancourtensis Apostolescu, 1956; p. 1337, pl. 2, figs. 27–29; pl. 4, figs. 53–56 (Lower Eocene, France); Cytheridae.

Volganella magna Spizharsky, 1956; p. 94, pl. 21, figs. 3–4, text-fig. 17 (Upper Permian, Tartarian, Russian Platform); Voganellidae.

Welleria bisulcata Smith, 1956; p. 5, pl. 1, figs. 8–11 (Middle Devonian, New York); Zygobolbidae.

Welleriopsis diplocystulis Swartz and Whitmore, 1956; p. 1075, pl. 105, figs. 9–13 (Upper Silurian, New Jersey); Zygobolbidae.

Welleriopsis jerseyensis var. *microreticulis* Swartz and Whitmore, 1956, n. var.; p. 1076, pl. 105, figs. 17–20 (Upper Silurian, New Jersey); Zygobolbidae.

Xestoleberis arcturi Triebel, 1956; p. 453, pl. 56, figs. 23–28; pl. 57, figs. 29–36; pl. 58, figs. 37–42 (Recent, Galapagos Islands); Xestoleberinae.

Youngiella? nodosa Harris and Jobe, 1956; p. 14, pl. 3, fig. 2a–d (Upper Mississippian, Oklahoma); Youngiellidae.

NEW NAMES IN 1956

Bairdoppilata roemeri Deroo, 1956; new species based on *Cytherina subdeltoidea* (Münster) of Roemer, 1840 (non *Cythere subdeltoidea* Münster, 1830) = *Bairdia alexandrina* Blake, 1931; p. 1509, pl. 1, figs. 9–12; Bairdiidae.

Paracypris trosliensis Apostolescu, 1956; new species based on *Bairdia arcuata* (Münster) of Bosquet, 1850 (non *Cythere arcuata* Münster, 1830); p. 1333, pl. 1, figs. 5–6 (Lower Eocene, France); Cytherellidae.

Protocythere? triebeli Deroo, 1956; new name for *Protocythere auriculata* Triebel, 1938; p. 1515; Cytheridae.

FORMS WITH NOMENCLATURA APERTA IN 1956

Amphissites sp., Crane and Kelly, 1956; p. 872, pl. 98, fig. 3 (Middle Mississippian, Meramecian, Michigan); Kirkbyidae.

Argilloecia sp., Skinner, 1956; p. 182, pl. 1, fig. 2a–b (Upper Cretaceous, Arkansas); Cypridídae.

Bairdia sp. no. 1, Crane and Kelly, 1956; p. 874, pl. 98, fig. 16 (Middle Mississippian, Meramecian, Michigan); Bairdiidae.

Bythocythere sp. *A*, Oertli, 1956; p. 75, pl. 10, figs. 261–263 (Oligocene, Switzerland); Cytheridae.

Cythereis sp. (indet.), Skinner, 1956; p. 195, pl. 3, fig. 5a–c (Upper Cretaceous, Arkansas); Cytheridae.

Cytherella sp. *A*, Oertli, 1956; p. 29, pl. 1, figs. 10–12 (Miocene, Switzerland); Cytherellidae.

Cytheretta sp. *A*, Oertli, 1956; p. 66, pl. 8, fig. 195 (Oligocene, Switzerland); Cytheridae.

Cytheromorpha sp. *A*, Oertli, 1956; p. 73, pl. 9, figs. 241–243 (Miocene, Switzerland); Cytheridae.

Eocytheropteron sp. *A*, Oertli, 1956; p. 75, pl. 10, figs. 259–260 (Oligocene, Switzerland); Cytheridae.

Eukloedenella sp., Stover, 1956; p. 1110, pl. 114, figs. 21–22 (Middle Devonian, New York); Kloedenellidae.

Glyptopleura sp. 1, Crane and Kelly, 1956; p. 872, pl. 98, fig. 4 (Middle Mississippian, Meramecian, Michigan); Glyptopleuridae.

Kemeroviana sp. (indet.), Mandelstam, 1956; p. 99, pl. 19, fig. 8 (Upper Permian, Siberia); Cypridae, Tomiellinae.

Mesomphalus sp., Swartz and Whitmore, 1956; p. 1079, pl. 105, fig. 8 (Upper Silurian, New Jersey); Zygobolbidae.

Neokloedenella sp., Stover, 1956; p. 1111, pl. 114, figs. 23–25 (Middle Devonian, New York); Kloedenellidae.

Parabolbina sp., Jaanusson and Martinsson, 1956; p. 408, pl. 1, figs. 7–8 (Middle Silurian, Sweden); Ctenoloculininae.

Perprimitia sp. 1, Crane and Kelly, 1956; p. 873, pl. 98, fig. 13 (Middle Mississippian, Meramecian, Michigan); Kloedenellidae.

Perprimitia sp. 2, Crane and Kelly, 1956; p. 873, pl. 98, fig. 12 (Middle Mississippian, Meramecian, Michigan); Kloedenellidae.

Perprimitia sp. 3, Crane and Kelly, 1956; p. 873, pl. 98, figs. 7–8 (Middle Mississippian, Meramecian, Michigan); Kloedenellidae.

Perprimitia sp. 4, Crane and Kelly, 1956; p. 874, pl. 98, figs. 9–10 (Middle Mississippian, Meramecian, Michigan); Kloedenellidae.

Phlyctiscapha? sp., Swartz and Whitmore, 1956; p. 1081, pl. 103, fig. 20 (Upper Silurian, New Jersey); Zygobolbidae.

Pontocypris sp. *A*, Oertli, 1956; p. 31, pl. 1, figs. 18–20 (Oligocene, Switzerland); Cypridídae.

Pterygocythereis sp. *A*, Oertli, 1956; p. 88, pl. 16, figs. 407–409 (Oligocene, Switzerland); Trachyleberidídae.

Quasillites sp., Stover, 1956; p. 1126, pl. 117, figs. 26–28 (Middle Devonian, New York); Quasillitidae.

Richina sp., Stover, 1956; p. 1108, pl. 113, fig. 10 (Middle Devonian, New York); Drepanellidae.

Schizocythere sp. *A*, Oertli, 1956; p. 53, pl. 6, figs. 147–149 (Oligocene, Switzerland); Cytheridae.

Thlipsuropsis sp., Swartz and Whitmore, 1956; pl. 110, fig. 13 (Upper Silurian, New Jersey); Thlipsuridae.

Waldeckella cicatricosa (Matern) n. subsp.(?) *A*, Kupfahl, 1956; p. 28, pl. 4, figs. 1–1a, text-fig. 2 (Upper Devonian, Germany).

Waldeckella cicatricosa (Matern) n. subsp.(?) *B*, Kupfahl, 1956; p. 29, pl. 4, figs. 3, 6 (Upper Devonian, Germany).

Waldeckella cicatricosa (Matern) n. subsp.(?) *C*, Kupfahl, 1956; p. 29, pl. 4, fig. 5 (Upper Devonian, Germany).

Genus and species undetermined *A*, Stover, 1956; p. 1139, pl. 119, figs. 33–34 (Middle Devonian, New York).

Genus and species undetermined *B*, Stover, 1956; p. 1139, pl. 119, figs. 35–36 (Middle Devonian, New York).

NOMINA NUDA IN 1956

Amphissites bradfieldi Elias, 1956 (*nomen nudum*); p. 88 (Upper Mississippian, Oklahoma).

Bairdia billjohnsoni Elias, 1956 (*nomen nudum*); p. 88 (Upper Mississippian, Oklahoma)

Bairdia croneisi Elias, 1956 (*nomen nudum*); p. 88 (Upper Mississippian, Oklahoma).

Cyprideis pacifica Hartmann, 1956*a* (*nomen nudum*); p. 241 (Recent, El Salvador).

Cythereis salvadoriana Hartmann, 1956*a* (*nomen nudum*); p. 230 (Recent, El Salvador).

Cytherina ostiicola Hartmann, 1956*a* (*nomen nudum*); p. 242 (Recent, El Salvador).

Cytherura palacii Hartmann, 1956*a* (*nomen nudum*); p. 242 (Recent, El Salvador).

Glyptopleura cooperi Elias, 1956 (*nomen nudum*); p. 88 (Upper Mississippian, Oklahoma).

Glyptopleura geissi Elias, 1956 (*nomen nudum*); p. 88 (Upper Mississippian, Oklahoma).

Glyptopleura scotti Elias, 1956 (*nomen nudum*); p. 88 (Upper Mississippian, Oklahoma).

Glyptopleura warthini Elias, 1956 (*nomen nudum*); p. 88 (Upper Mississippian, Oklahoma).

Healdia harltoni Elias, 1956 (*nomen nudum*); p. 88 (Upper Mississippian, Oklahoma).
Hollinella radiata var. *dotti* Elias, 1956, n. var. (*nomen nudum*); p. 88 (Upper Mississippian, Oklahoma).
Iliocythere dentato-marginata Hartmann, 1956*a* (*nomen nudum*); p. 242 (Recent, El Salvador).
Iliocythere punctata Hartmann, 1956*a* (*nomen nudum*); p. 242 (Recent, El Salvador).
Nuferella rothi Elias, 1956 (*nomen nudum*); p. 88 (Upper Mississippian, Oklahoma).
Paracytheroma costata Hartmann, 1956*a* (*nomen nudum*); p. 243 (Recent, El Salvador).
Paracytheroma levia Hartmann, 1956*a* (*nomen nudum*); p. 243 (Recent, El Salvador).
Paracytheroma unduli-marginata Hartmann, 1956*a* (*nomen nudum*); p. 243 (Recent, El Salvador).
Pericythere Hartmann, 1956*a*, n. gen. (*nomen nudum*); p. 242 (Recent, El Salvador).
Pericythere foveata Hartmann, 1956*a* (*nomen nudum*); p. 242 (Recent, El Salvador).
Polytylites coryelli Elias, 1956 (*nomen nudum*); p. 88 (Upper Mississippian, Oklahoma).
Polytylites kellettae Elias, 1956 (*nomen nudum*); p. 88 (Upper Mississippian, Oklahoma).
Pontocyprella akatagensis Mandelstam, in Mandelstam and others, 1956 (*nomen nudum*); pl. 23, fig. 3a–b (species figured but not described).
Sansabella bassleri Elias, 1956 (*nomen nudum*); p. 88 (Upper Mississippian, Oklahoma).
Thalassocypria aestuarina Hartmann, 1956*a* (*nomen nudum*); p. 241 (Recent, El Salvador).
Thalassocypria elongata Hartmann, 1956*a* (*nomen nudum*); p. 241 (Recent, El Salvador).

SUPPLEMENT TO BIBLIOGRAPHY FOR 1950–1955

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CHASE, A. M., AND BRIGHAM, E. H.
*1952 – *Studies on cell enzyme systems; 6 – Competitive inhibition of Cypridina luciferace by butyl alcohol.* Jour. Cell. Comp. Physiol., vol. 39, no. 2, pp. 269–280, 3 text-figs.

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*1952 – *Ostracode zones as guides to the "fractured reservoir section" of the lower Green River formation, Uinta Basin, Utah.* (Abstract.) Amer. Assoc. Petr. Geol., Bull., vol. 36, no. 5, p. 921.

DANISCH, E.
*1955 – *Über die Fauna der Kimmeridge- und Gigas-Schichten zwischen Engter und Venne.* Naturw. Ver. Osnabrück, Jahresber., vol. 27, pp. 54–74 (not seen).

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FERGUSON, E., JR.
*1952 – *A preliminary report on the freshwater ostracods of Orangeburg County, South Carolina.* Amer. Microsc. Soc., Trans., vol. 71, no. 3, pp. 272–276.

FIEBIG, H.
*1955*a* – *Feinstratigraphisch-fazielle Untersuchungen der oberen Bochumer Schichten (oberes Westfal A) am linken Niederrhein.* Geol. Jahrb., vol. 70, pp. 611–656, 1 pl., 17 text-figs. (not seen).

*1955*b* – *Die Ausbildung der Wittener (Eßkohlen-) Schichten und die Gleichsetzung und einheitliche Benennung der Flöze im mittleren und westlichen Ruhrgebiet.* Glückauf, vol. 91, pp. 1181–1187, 2 text-figs.

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1953 – *Iliocythere meyer-abichi nov. spec., ein Ostracode des Schlickwattes von San Salvador.* Zool. Anz., vol. 151, no. 11/12, pp. 310–316, text-figs. 1–17.

1954*a* – *Neue Polycopidae (Ostracoda Cladocopa) von europäischen Küsten.* Kieler Meeresforschungen, vol. 10, no. 1, pp. 84–99, pls. 24–34.

1954*b* – *Zwei neue Polycope-Arten (Ostracoda Cladocopa) aus Brasilien.* Zool. Anz., vol. 153, pt. 7/8, pp. 175–182, 22 text-figs.

1954*c* – *Ostracodes des eaux souterraines littorales de la Méditerranée et de Majorque.* Vie et Milieu, vol. 4, pt. 2, pp. 238–253, 6 text-figs.

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1955 – *Ostracods of the genus Entocythere from the New River system in North Carolina, Virginia and West Virginia.* Amer. Microsc. Soc., Trans., vol. 74, no. 4, pp. 325–333, text-figs. 1–10.

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1955 – *Ostracoda from the sediments of the Saratov region and the northern district of the Stalingrad region.* In: LIUBIMOVA, P. C., AND KHABAROVA, T. H., *Ostracoda of the Mesozoic sediments from the Volga-Ural region.* All-Union Petrol. Sci.-Res. Geol. Expl. Inst. (VNIGRI), Trans., new ser., no. 84, pp. 191–198, pl. 1.

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1955 – *Microfaunistische und stratigraphisch-fazielle Untersuchungen im Kimmeridge und Portland des Weser-Aller-Gebietes.* Geol. Jahrb., vol. 70, pp. 167–246, 17 pls., 7 text-figs. (not seen).

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SUPPLEMENT TO NEW SUBGENERA, GENERA AND SUPRAGENERIC CATEGORIES IN 1950–1955

Bohemina Sňajdr, 1951; new subgenus of *Tricornina* Bouček, 1936; *Tricornina* (*Bohemina*) *prantli* Sňajdr, 1951; pp. 204–205, pl. 1, figs. 1–4 (Middle Devonian, Czechoslovakia); Middle Devonian, marine, Hollinidae, Ctenentominae.

CAVELLININAE Egorov, 1950; p. 109; new subfamily erected to include the genera: *Cavellina, Sulcocavellina, Timanella, Donellina.*

Donellina Egorov, 1950; *D. grandis* Egorov, 1950; p. 120, pl. 8, figs. 26–41 (Upper Devonian, Russia); Upper Devonian, marine, Kloedenellidae.

Dordoniella Apostolescu, 1955; *D. strangulata* Apostolescu, 1955; p. 329, text-figs. 1–6 (Upper Cretaceous, France); Upper Cretaceous, marine, Cytheridae, Cytherinae.

Evlanella Egorov, 1950; *E. ljaschenkoi* Egorov, 1950; p. 63, pl. 13, figs. 1–10, text-fig. 8(5) (Upper Devonian, Russia); Upper Devonian, marine, Kloedenellidae.

Evlanovia Egorov, 1950; *E. tichonovitchi* Egorov, 1950; p. 74, pl. 9, figs. 1–12 (Upper Devonian, Russia); Upper Devonian, marine, Kloedenellidae.

Gipsella Egorov, 1950; *G. polkvoii* Egorov, 1950; p. 32, pl. 3, figs. 27–33, 38–40 (Upper Devonian, Russia); Upper Devonian, marine, Kloedenellidae.

GLYPTOPLEURINAE Egorov, 1950; p. 102; new subfamily erected to include the genera *Glyptopleura* and *Beyrichiopsis.*

Hupehella Hou, 1955; *H. lunata* Hou, 1955; pp. 220, 240, pl. 8, figs. 16–21 (Upper Devonian, Hupeh, China); Upper Devonian, marine, family uncertain.

Kalugia Egorov, 1950; *K. ivanovi* Egorov, 1950; p. 67, pl. 13, figs. 11–22, text-fig. 8(1–2) (Upper Devonian, Russia); Upper Devonian, marine, Kloedenellidae.

KLOEDENELLINAE Egorov, 1950; p. 19; new subfamily erected to include the genera: *Mennerella, Gipsella, Semilukiella, Uchtovia, Kloedenella.*

Kloedenellitina Egorov, 1950; *K. symaeformis* (Batalina); p. 52, pl. 10, figs. 1–10 (Upper Devonian, Russia); Upper Devonian, marine, Kloedenellidae.

Knoxiella Egorov, 1950; *K. semilukiana* Egorov, 1950; p. 90, pl. 15, figs. 25–34 (Upper Devonian, Russia); Upper Devonian, marine, Kloedenellidae.

KNOXINAE Egorov, 1950; p. 74; new subfamily erected to include the genera: *Milanovskya, Evlanovia, Chesterella, Knoxites, Knoxiella.* [The name of this subgenus should read "Knoxitinae" or "Knoxiellinae," depending upon whether *Knoxites* or *Knoxiella* is the type genus.]

Knoxites Egorov, 1950; *K. menneri* Egorov, 1950; p. 84, pl. 14, figs. 1–18, 26–27 (Upper Devonian, Russia); Upper Devonian, marine, Kloedenellidae.

Kuleschovkia Egorov, 1950; *K. fursenkoi* Egorov, 1950; p. 71, pl. 12, figs. 37–40, text-fig. 8(6) (Upper Devonian, Russia); Upper Devonian, marine, Kloedenellidae.

Lichvinia (Posner in litt.), in Egorov, 1950; *L. lichvinensis* (Posner in litt.), in Egorov, 1950; p. 69; apparently a *nomen nudum.*

LICHVININAE (Posner in litt.), in Egorov, 1950; p. 61; new subfamily erected to include the genera: *Evlanella, Kuleschovkia, Kalugia, Lichvinia.* [The validity of this subfamily name is doubtful, inasmuch as the type genus, *Lichvinia,* is believed to be a *nomen nudum.*]

Mennerella Egorov, 1950; *M. tuberosa* (Glebovskaia and Zaspelova in litt.), in Egorov, 1950; p. 21, pl. 1, figs. 1–32; pl. 2, figs. 1–11 (Upper Devonian, Russia); Upper Devonian, marine, Kloedenellidae.

Mennerites Egorov, 1950; *M. svinordensis* Egorov, 1950; p. 46, pl. 10, figs. 26–46 (Upper Devonian, Russia); Upper Devonian, marine, Kloedenellidae.

Microloxoconcha Hartmann, 1954*c*; *M. compressa* Hartmann, 1954*c*; pp. 245–246, text-fig. 4a–g (Recent, France); Recent, marine.

Milanovskya Egorov, 1950; *M. bicornis* (Glebovskaia and Zaspelova in litt.), in Egorov, 1950; p. 79, pl. 9, figs. 13–25 (Upper Devonian, Russia); Upper Devonian, marine, Kloedenellidae.

Parapontoparta Hartmann, 1955; *P. arcuata* Hartmann, 1955; pp. 109–110, text-figs. 1–11 (Recent, Brazil); Recent, marine, Cyprididae, Candocyprinae.

Perijonesina Hou, 1955; *P. sinensis* Hou, 1955; pp. 214, 235, pl. 4, figs. 11–19; pl. 5, figs. 1–29; pl. 6, figs. 1–6 (Upper Devonian, Hupeh, China); Upper Devonian, marine, Kloedenellidae, Cavellininae.

Perimarginia Hou, 1955; *P. tuberosa* Hou, 1955; pp. 211, 231, pl. 2, figs. 1–24; pl. 3, figs. 1, 4–8, 9–11 (Upper Devonian, Hupeh, China); Upper Devonian, marine, Kloedenellidae, Cavellininae.

PERPRIMITIINAE Egorov, 1950; p. 44; new subfamily erected to include the genera: *Mennerites, Perprimitia, Jonesina, Kloedenellitina.*

PROTOCYTHERINAE (Mandelstam in litt.), in Liubimova, 1955; p. 68; new subfamily.

Semilukiella Egorov, 1950; *S. zaspelovae* Egorov, 1950; p. 36, pl. 4, figs. 1–21 (Upper Devonian, Russia); Upper Devonian, marine, Kloedenellidae.

Sinoprimitia Hou, 1953*b*; *S. sinensis* Hou, 1953*b*; pp. 71–77, pl. 1, fig. 4a–b (Lower Ordovician, Hupeh, China); Lower Ordovician, marine, Primitiidae.

Sulcocavellina Egorov, 1950; *S. incognita* Egorov, 1950; p. 117, pl. 7, figs. 1–13 (Upper Devonian, Russia); Upper Devonian, marine, Kloedenellidae.

Thalassocypris Hartmann, 1955; *T. elongata* Hartmann, 1955; p. 114, text-figs. 12–23 (Recent, Brazil); Recent, marine, Cyprididae, Candocyprinae.

Timanella Egorov, 1950; *T. typica* Egorov, 1950; p. 119, pl. 7, figs. 33–39 (Upper Devonian, Russia); Upper Devonian, marine, Kloedenellidae.

Trinota Hou, 1955; *T. constata* Hou, 1955; pp. 221, 241, pl. 8, figs. 22–26 (Upper Devonian, Hupeh, China); Upper Devonian, marine, family uncertain.

Uchtovia Egorov, 1950; *U. polenovae* Egorov, 1950; p. 40, pl. 5, figs. 14–35 (Upper Devonian, Russia); Upper Devonian, marine, Kloedenellidae.

SUPPLEMENT TO NEW SPECIES, SUBSPECIES AND VARIETIES IN 1950–1955

Aequacytheridea alta Liubimova, 1955; p. 99, pl. 11, fig. 3a–b (Upper Jurassic, Russia); Cytheridae.

Aequacytheridea araneusa Liubimova, 1955; p. 97, pl. 11, fig. 5a–b (Upper Jurassic, Russia); Cytheridae.

Aequacytheridea delicata Liubimova, 1955; p. 98, pl. 11, fig. 7a–b (Upper Jurassic, Russia); Cytheridae.

Aequacytheridea ignara Liubimova, 1955; p. 100, pl. 12, fig. 2a–b (Upper Jurassic, Russia); Cytheridae.

Aequacytheridea major Liubimova, 1955; p. 100, pl. 11, fig. 6a–b (Upper Jurassic, Russia); Cytheridae.

Aequacytheridea praeclara Liubimova, 1955; p. 102, pl. 12, fig. 1a–b (Upper Jurassic, Russia); Cytheridae.

Aequacytheridea samaraensis Liubimova, 1955; p. 103, pl. 11, fig. 2a–c (Lower Cretaceous, Russia); Cytheridae.

Aequacytheridea spatiosa Liubimova, 1955; p. 101, pl. 11, fig. 4a–b (Upper Jurassic, Russia); Cytheridae.

Aequacytheridea splendens Liubimova, 1955; p. 103, pl. 10, fig. 10a–b (Lower Cretaceous, Russia); Cytheridae.

Aequacytheridea subrotunda Liubimova, 1955; p. 99, pl. 11, fig. 8a–b (U pper Jurassic, Russia); Cytheridae.

Aequacytheridea translucida Liubimova, 1955; p. 97, pl. 11, fig. 1a–b (Upper Jurassic, Russia); Cytheridae.

Aglaia affinis Schneider, 1953; p. 107, pl. 1, fig. 4a–b (Middle Miocene, western Ukraine).

Amphissites sinensis Hou, 1954; pp. 232, 251, pl. 1, fig. 4 (Lower Permian, Hupeh, China); Kirkbyidae.

Amphissites subcentronotus Hou, 1954; pp. 232, 252, pl. 1, fig. 5 (Lower Permian, Hupeh, China); Kirkbyidae.

Aparchites sinensis Hou, 1954; pp. 229, 248, pl. 1, fig. 1a–b (Lower Permian, Hupeh, China); Aparchitidae.

Bairdia changyangensis Hou, 1954; pp. 238, 258, pl. 2, fig. 2a–b (Lower Permian, Hupeh, China); Bairdiidae.

Bairdia convexa Hou, 1954; pp. 236, 256, pl. 1, fig. 12a–b (Lower Permian, Hupeh, China); Bairdiidae.

Bairdia explicata Schneider, 1953; p. 122, pl. 4, fig. 5 (Middle Miocene, western Ukraine).

Bairdia fusiformis Hou, 1954; pp. 237, 258, pl. 2, fig. 1a–d (Lower Permian, Hupeh, China); Bairdiidae.

Bairdia hupeiensis Hou, 1954; pp. 237, 257, pl. 1, fig. 14 (Lower Permian, Hupeh, China); Bairdiidae.

Bairdia mui Hou, 1954; pp. 239, 259, pl. 2, fig. 4a–d (Lower Permian, Hupeh, China); Bairdiidae.

Bairdia sinensis Hou, 1954; pp. 238, 259, pl. 2, fig. 3a–c (Lower Permian, Hupeh, China); Bairdiidae.

Bairdia subrounda Hou, 1954; pp. 236, 257, pl. 1, fig. 13a–c (Lower Permian, Hupeh, China); Bairdiidae.

Bairdia yangi Hou, 1954; pp. 239, 260, pl. 2, fig. 5a–d (Lower Permian, Hupeh, China); Bairdiidae.

Beyrichia mui Hou, 1955*a*; pp. 208, 229, pl. 1, figs. 21–25 (Upper Devonian, Hupeh, China); Beyrichiidae.

Bythocypris maanshanensis Hou, 1954; pp. 240, 262, pl. 1, fig. 16a–d (Lower Permian, Hupeh, China); Bairdiidae.

Bythocypris subcircularis Hou, 1953*b*; pp. 73–78, pl. 1, fig. 6a–b (Lower Ordovician, Hupeh, China); Bairdiidae.

Bythocythere aliena Liubimova, 1955; p. 34, pl. 2, fig. 3a–b (Upper Jurassic, Russia); Paradoxostomidae.

Bythocythere calloveica Mandelstam, 1955, in Liubimova, 1955; p. 30, pl. 1, fig. 10a–b (Upper Jurassic, Russia); Paradoxostomidae.

Bythocythere faceta Liubimova, 1955; p. 32, pl. 2, fig. 1 (Upper Jurassic, Russia); Paradoxostomidae.

Bythocythere gerdae Liubimova, 1955; p. 31, pl. 2, fig. 4 (Upper Jurassic, Russia); Paradoxostomidae.

Bythocythere nescia Liubimova, 1955; p. 33, pl. 2, fig. 2a–b (Upper Jurassic, Russia); Paradoxostomidae.

Candona procházkai Pokorný, 1955; p. 275, text-figs. 3–5, pl. 1, figs. 1–4 (Lower Pliocene, Czechoslovakia).

Cavellina devoniana Egorov, 1950; p. 116, pl. 7, figs. 26–32 (Upper Devonian, Russia); Kloedenellidae.

Cavellina epichinensis Egorov, 1950; p. 114, pl. 8, figs. 21–25 (Upper Devonian, Russia); Kloedenellidae.

Cavellina hupehensis Hou, 1955*a*; pp. 216, 237, pl. 6, figs. 7–25 (Upper Devonian, Hupeh, China); Kloedenellidae, Cavellininae.

Cavellina latiovata Hou, 1955*a*; pp. 217, 237, pl. 9, figs. 1–8 (Upper Devonian, Hupeh, China); Kloedenellidae, Cavellininae.

Cavellina maanshanensis Hou, 1954; pp. 242, 263, pl. 2, fig. 10a–b (Lower Permian, Hupeh, China); Cytherellidae.

Cavellina mui Hou, 1954; pp. 242, 264, pl. 2, fig. 11a–b (Lower Permian, Hupeh, China); Cytherellidae.

Cavellina quasiattenuata Egorov, 1950; p. 112, pl. 8, figs. 1–20 (Upper Devonian, Russia); Kloedenellidae.

Cavellina sinensis Hou, 1955*a*; pp. 218, 238, pl. 7, figs. 2–8, 16–27 (Upper Devonian, Hupeh, China); Kloedenellidae, Cavellininae.

Cavellina uchtensis Egorov, 1950; p. 115, pl. 7, figs. 14–25 (Upper Devonian, Russia); Kloedenellidae.

Chesterella alexandrovae Egorov, 1950; p. 83, pl. 11, figs. 33–42 (Upper Devonian, Russia); Kloedenellidae.

Chesterella valentinae Egorov, 1950; p. 82, pl. 11, figs. 23–32 (Upper Devonian, Russia); Kloedenellidae.

Ctenobolbina nanmanensis Hou, 1953*a*; pp. 41, 46, pl. 1, fig. 3 (Lower Ordovician, Liaotung, China); Hollinidae.

Ctenobolbina sinensis Hou, 1953*a*; pp. 41, 47, pl. 1, fig. 4 (Lower Ordovician, Liaotung, China); Hollinidae.

Ctenobolbina sinensis var. *wangi* Hou, 1953*a*; pp. 42, 47, pl. 1, fig. 5 (Lower Ordovician, Liaotung, China); Hollinidae.

Ctenobolbina taitzehoensis Hou, 1953*a*; pp. 42, 48, pl. 1, fig. 6 (Lower Ordovician, Liaotung, China); Hollinidae.

Cyprideis multidentata Hartmann, 1955; p. 119, text-figs. 24–34 (Recent, Brazil); Cytheridae.

Cyprideis saetosa Hartmann, 1955; p. 125, text-figs. 35–44 (Recent, Brazil); Cytheridae.

Cythere ukrainica Schneider, 1953; pp. 111–112, pl. 4, fig. 4a–b (Middle Miocene, western Ukraine).

Cythere volhynica Schneider, 1953; p. 111, pl. 1, fig. 3 (Upper Miocene, western Ukraine).

Cythereis angularis Schneider, 1953; pp. 112–113, pl. 2, fig. 6 (Upper Miocene, western Ukraine).

Cythereis aritis Schneider, 1953; p. 112, pl. 3, fig. 4 (Middle Miocene, western Ukraine).
Cythereis laskarevi Schneider, 1953; p. 118, pl. 3, fig. 1 (Middle Miocene, western Ukraine).
Cythereis magna Schneider, 1953; p. 117, pl. 3, fig. 8 (Middle Miocene, western Ukraine).
Cythereis mjatliukae Schneider, 1953; pp. 114–115, pl. 3, fig. 7 (Middle Miocene, western Ukraine).
Cythereis neglecta Schneider, 1953; pp. 119–120, pl. 2, fig. 3 (Upper Miocene, western Ukraine).
Cythereis plicata Schneider, 1953; p. 120, pl. 4, fig. 6 (Middle Miocene, western Ukraine).
Cythereis podolica Schneider, 1953; pp. 113–114, pl. 3, fig. 6 (Middle Miocene, western Ukraine).
Cythereis suzini Schneider, 1953; pp. 118–119, pl. 2, fig. 7 (Upper Miocene, western Ukraine).
Cythereis villierensis Stchepinsky, 1955; p. 498, pl. 22, fig. 10; text-pl. 5, fig. 33 (Lower Cretaceous, France); Loxoconchinae.
Cytherella designata Liubimova, 1955; p. 110, pl. 13, fig. 5a–b (Upper Jurassic, Russia); Cytherellidae.
Cytherella irgisensis Liubimova, 1955; p. 108, pl. 12, fig. 5a–b (Upper Jurassic, Russia); Cytherellidae.
Cytherella lepida Liubimova, 1955; p. 109, pl. 13, fig. 3a–c (Upper Jurassic, Russia); Cytherellidae.
Cytherella nota Liubimova, 1955; p. 106, pl. 13, fig. 1a–c (Upper Jurassic, Russia); Cytherellidae.
Cytherella ornata Liubimova, 1955; p. 111, pl. 13, fig. 4a–d (Upper Jurassic, Russia); Cytherellidae.
Cytherella tortuosa Liubimova, 1955; p. 110, pl. 13, fig. 2a–d (Upper Jurassic, Russia); Cytherellidae.
Cytherella ukrainkaensis Liubimova, 1955; p. 106, pl. 12, fig. 6a–c (Upper Jurassic, Russia); Cytherellidae.
Cytheretta janischewskyi Schneider, 1953; pp. 120–121, pl. 3, fig. 5 (Middle Miocene, western Ukraine).
Cytherideis mediterranea Schneider, 1953; p. 121, pl. 1, fig. 1 (Middle Miocene, western Ukraine).
Cytherideis tenuis Schneider, 1953; pp. 121–122, pl. 4, fig. 3 (Middle Miocene, western Ukraine).
Cytheromorpha elongata Hartmann, 1954*c*; p. 250, text-fig. 6a–j (Recent, France).
Cytheropteron pantaleonensis Stchepinsky, 1955; p. 496, pl. 22, fig. 4, text-pl. 4, fig. 24 (Lower Cretaceous, France); Loxoconchinae.
Cytheropteron? spinosum Liubimova, 1955; p. 95, pl. 10, fig. 9a–b (Upper Jurassic, Russia); Cytheridae.
Cytherura alveolata Schneider, 1953; p. 107, pl. 1, fig. 6 (Middle Miocene, western Ukraine).
Cytherura bacuana Schneider, 1953; p. 108, pl. 1, fig. 5 (Middle Miocene, western Ukraine).
Cytherura quadratovolatilis Hartmann, 1954*e*; p. 650, text-fig. 1a–d (Recent, France).
Cytherura quadridentata Hartmann, 1954*e*; p. 652, text-fig. 2a–d (Recent, France).
Darwinula accepta Liubimova, 1955; p. 28, pl. 1, fig. 8a–b (Lower Triassic, Russia); Darwinulidae.
Darwinula adducta Liubimova, 1955; p. 27, pl. 1, fig. 7a–b (Lower Triassic, Russia); Darwinulidae.
Darwinula ingrata Liubimova, 1955; p. 29, pl. 1, fig. 9 (Lower Triassic, Russia); Darwinulidae.
Donellina grandis Egorov, 1950; p. 121, pl. 8, figs. 26–41 (Upper Devonian, Russia); Kloedenellidae.
Dordoniella strangulata Apostolescu, 1955; p. 330, text-figs. 1–6 (Upper Cretaceous, France); Cytheridae, Cytherinae.
Entocythere caudata Kozloff, 1955; p. 156, text-figs. 1–12 (Recent, Oregon).
Entocythere daphnioides Hobbs, 1955; p. 325, text-figs. 1–2, 5–9 (Recent, eastern United States).
Entocythere ericksoni Kozloff, 1955; p. 159, text-figs. 13–25 (Recent, Oregon).
Entocythere runki Hobbs, 1955; p. 330, text-figs. 3–4, 10 (Recent, eastern United States).
Eocytheropteron wassyensis Stchepinsky, 1955; p. 496, pl. 22, fig. 5, text-pl. 4, fig. 25 (Lower Cretaceous, France); Loxoconchinae.
Evlanella incognita Egorov, 1950; p. 65, pl. 13, figs. 30–43, text-fig. 8(4) (Upper Devonian, Russia); Kloedenellidae.
Evlanella ljaschenkoi Egorov, 1950; p. 64, pl. 13, figs. 1–10, text-fig. 8(5) (Upper Devonian, Russia); Kloedenellidae.
Evlanovia cornigellaformis Egorov, 1950; p. 77, pl. 9, figs. 35–37 (Upper Devonian, Russia); Kloedenellidae.
Evlanovia pigmensis Egorov, 1950; p. 76, pl. 9, figs. 26–31 (Upper Devonian, Russia); Kloedenellidae.
Evlanovia tichonovitchi Egorov, 1950; p. 75, pl. 9, figs. 1–12 (Upper Devonian, Russia); Kloedenellidae.
Evlanovia venjukovi Egorov, 1950; p. 78, pl. 9, figs. 32–34 (Upper Devonian, Russia); Kloedenellidae.
Exophthalmocythere affabra Liubimova, 1955; p. 87, pl. 10, fig. 3a–b (Upper Jurassic, Russia); Cytheridae.
Exophthalmocythere justa Liubimova, 1955; p. 88, pl. 10, fig. 4a–b (Upper Jurassic, Russia); Cytheridae.
Exophthalmocythere tricornis Liubimova, 1955; p. 87, pl. 10, fig. 2a–b (Upper Jurassic, Russia); Cytheridae.
Gipsella evlanensis Egorov, 1950; p. 35, pl. 3, figs. 34–37 (Upper Devonian, Russia); Kloedenellidae.
Gipsella polkvoii Egorov, 1950; p. 33, pl. 3, figs. 27–33, 38–40 (Upper Devonian, Russia); Kloedenellidae.
Glyptopleura raabenae Egorov, 1950; p. 107, pl. 17, figs. 1–11 (Upper Devonian, Russia); Kloedenellidae.
Glyptopleura sokolskyae Egorov, 1950; p. 106, pl. 17, figs. 12–31 (Upper Devonian, Russia); Kloedenellidae.
Hollinella pseudotingi Hou, 1954; pp. 231, 251, pl. 1, fig. 3a–b (Lower Permian, Hupeh, China); Hollinellidae.
Hupehella lunata Hou, 1955*a*; pp. 220, 241, pl. 8, figs. 16–21 (Upper Devonian, Hupeh, China); family uncertain.
Ilyocythere meyer-abichi Hartmann, 1953; p. 310, text-figs. 1–17 (Recent, San Salvador).
Isocypris laskaridisi Herbst, 1951; p. 405, text-figs. 4–7 (Recent, Germany).
Jonesina quasifastigiata Egorov, 1950; p. 60, pl. 12, figs. 1–13 (Upper Devonian, Russia); Kloedenellidae.
Kalugia ivanovi Egorov, 1950; p. 68, pl. 13, figs. 11–22, text-fig. 8(1–2) (Upper Devonian, Russia); Kloedenellidae.

Kellettina elongata Hou, 1954; pp. 235, 254, pl. 1, fig. 9a–b (Lower Permian, Hupeh, China); Kirkbyidae.

Kirkbya canyonformis Hou, 1954; pp. 233, 253, pl. 1, fig. 7a–b (Lower Permian, Hupeh, China); Kirkbyidae.

Kirkbya sinensis Hou, 1954; pp. 233, 253, pl. 1, fig. 6a–b (Lower Permian, Hupeh, China); Kirkbyidae.

Kloedenellitina batalinae Egorov, 1950; p. 55, pl. 10, figs. 11–16 (Upper Devonian, Russia); Kloedenellidae.

Kloedenellitina kuleschovkensis Egorov, 1950; p. 56, pl. 10, figs. 17–25 (Upper Devonian, Russia); Kloedenellidae.

Kloedenellitina pseudosymaeformis Egorov, 1950; p. 58, pl. 12, figs. 14–36 (Upper Devonian, Russia); Kloedenellidae.

Knightina reticulata Hou, 1954; pp. 235, 255, pl. 1, fig. 10 (Lower Permian, Hupeh, China); Kirkbyidae.

Knoxiella cerata Egorov, 1950; p. 101, pl. 18, figs. 1–13 (Upper Devonian, Russia); Kloedenellidae.

Knoxiella donensis Egorov, 1950; p. 91, pl. 15, figs. 17–24 (Upper Devonian, Russia); Kloedenellidae.

Knoxiella konensis Egorov, 1950; p. 94, pl. 15, figs. 35–45 (Upper Devonian, Russia); Kloedenellidae.

Knoxiella minima Egorov, 1950; p. 100, pl. 16, figs. 28–33 (Upper Devonian, Russia); Kloedenellidae.

Knoxiella posneri Egorov, 1950; p. 96, pl. 15, figs. 1–16 (Upper Devonian, Russia); Kloedenellidae.

Knoxiella semilukiana Egorov, 1950; p. 93, pl. 15, figs. 25–34 (Upper Devonian, Russia); Kloedenellidae.

Knoxiella variabilis (Glebovskaia and Zaspelova in litt.), in Egorov, 1950; p. 97, pl. 16, figs. 1–13 (Upper Devonian, Russia); Kloedenellidae.

Knoxiella wibitiensis Egorov, 1950; p. 98, pl. 16, figs. 14–27 (Upper Devonian, Russia); Kloedenellidae.

Knoxites bolchovitinovae Egorov, 1950; p. 87, pl. 14, figs. 28–41 (Upper Devonian, Russia); Kloedenellidae.

Knoxites cornutus Egorov, 1950; p. 89, pl. 14, figs. 19–25 (Upper Devonian, Russia); Kloedenellidae.

Knoxites menneri Egorov, 1950; p. 85, pl. 14, figs. 1–18, 26–27 (Upper Devonian, Russia); Kloedenellidae.

Kuleschovkia fursenkoi Egorov, 1950; p. 72, pl. 12, figs. 37–40, text-fig. 8(6) (Upper Devonian, Russia); Kloedenellidae.

Leptocythere crucifera Hartmann, 1954*e*; p. 655, text-fig. 3a–d (Recent, France).

Leptocythere foveata Hartmann, 1954*e*; p. 656, text-fig. 4a–d (Recent, France).

Leptocythere petiti Hartmann, 1954*f*; p. 709, text-fig. 1a–f (Recent, France).

Lichvinia malevkensis (Posner in litt.), in Egorov, 1950; p. 70, pl. 13, figs. 23–29, text-fig. 9(3) (Upper Devonian, Russia); Kloedenellidae.

Loxoconcha buglovensis Schneider, 1953; pp. 109–110, pl. 4, fig. 2 (Middle Miocene, western Ukraine).

Loxoconcha cornuta Schneider, 1953; p. 110, pl. 4, fig. 1a–b (Middle Miocene, western Ukraine).

Loxoconcha lucida Schneider, 1953; pp. 110–111, pl. 1, fig. 2 (Middle Miocene, western Ukraine).

Loxoconcha tuberosa Hartmann, 1954*c*; p. 248, text-fig. 5a–i (Recent, France).

Mandelstamia abdita Liubimova, 1955; p. 65, pl. 7, fig. 1a–c (Upper Jurassic, Russia); Cytheridae.

Mandelstamia ignobilis Liubimova, 1955; p. 66, pl. 7, fig. 3a–b (Upper Jurassic, Russia); Cytheridae.

Mandelstamia verrucifera Liubimova, 1955; p. 64, pl. 7, fig. 4 (Upper Jurassic, Russia); Cytheridae.

Mennerella heckeri Egorov, 1950; p. 27, pl. 3, figs. 1–10 (Upper Devonian, Russia); Kloedenellidae.

Mennerella krestovnikovi Egorov, 1950; p. 28, pl. 3, figs. 11–20 (Upper Devonian, Russia); Kloedenellidae.

Mennerella ostrovensis Egorov, 1950; p. 29, pl. 3, figs. 21–26 (Upper Devonian, Russia); Kloedenellidae.

Mennerella porezkyae Egorov, 1950; p. 25, pl. 2, figs. 12–35 (Upper Devonian, Russia); Kloedenellidae.

Mennerella schelonica (Glebovskaia and Zaspelova in litt.), in Egorov, 1950; p. 31, pl. 5, figs. 1–13 (Upper Devonian, Russia); Kloedenellidae.

Mennerella tuberosa (Glebovskaia and Zaspelova in litt.), in Egorov, 1950; p. 23, pl. 1, figs. 1–32; pl. 2, figs. 1–11 (Upper Devonian, Russia); Kloedenellidae.

Mennerites evlanensis Egorov, 1950; p. 49, pl. 11, figs. 1–10 (Upper Devonian, Russia); Kloedenellidae.

Mennerites hupehensis Hou, 1955*a*; pp. 210, 230, pl. 8, figs. 1–15 (Upper Devonian, Hupeh, China); Kloedenellidae, Perprimitiinae.

Mennerites ovatus Egorov, 1950; p. 51, pl. 11, figs. 11–22, 43 (Upper Devonian, Russia); Kloedenellidae.

Mennerites svinordensis Egorov, 1950; p. 47, pl. 10, figs. 26–46 (Upper Devonian, Russia); Kloedenellidae.

Microcythere subterranea Hartmann, 1954*c*; p. 239, text-fig. 1a–g (Recent, France).

Microloxoconcha compressa Hartmann, 1954*c*; p. 246, text-fig. 4a–g (Recent, France).

Milanovskya bicornis (Glebovskaia and Zaspelova in litt.), in Egorov, 1950; p. 80, pl. 11, figs. 13–25 (Upper Devonian, Russia); Kloedenellidae.

Orthonotacythere alma Liubimova, 1955; p. 92, pl. 10, fig. 8a–b (Upper Jurassic, Russia); Cytheridae.

Orthonotacythere kostytschevkaensis Liubimova, 1955; p. 91, pl. 10, fig. 6a–b (Upper Jurassic, Russia); Cytheridae.

Orthonotacythere paula Liubimova, 1955; p. 90, pl. 10, fig. 7a–c (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea archangelski Mandelstam, 1955, in Liubimova, 1955; p. 39, pl. 4, fig. 1a–b (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea aspera Khabarova, 1955; p. 196, pl. 1, fig. 2a–b (Middle Jurassic, Russia); Cytheridae.

Palaeocytheridea baculumbajula Mandelstam, 1955, in Liubimova, 1955; p. 45, pl. 6, fig. 7 (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea bajociensis Khabarova, 1955; p. 196, pl. 1, fig. 3 (Middle Jurassic, Russia); Cytheridae.

Palaeocytheridea cinicinnusa Mandelstam, 1955, in Liubimova, 1955; p. 37, pl. 4, fig. 2a–b (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea conspecta Liubimova, 1955; p. 49, pl. 6, fig. 6a–b (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea descripta Liubimova, 1955; p. 41, pl. 5, fig. 4a–b (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea fornicata Liubimova, 1955; p. 52, pl. 6, fig. 5a–b (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea legitima Liubimova, 1955; p. 43, pl. 4, fig. 5a–b (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea mandelstami Liubimova, 1955; p. 42, pl. 4, fig. 4a–b (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea milanovskyi Liubimova, 1955; p. 38, pl. 6, fig. 1a–d (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea miranda Liubimova, 1955; p. 46, pl. 4, fig. 6a–b (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea monstrata Liubimova, 1955; p. 44, pl. 5, fig. 1a–c (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea neocomiensis Liubimova, 1955; p. 58, pl. 5, fig. 2a–c (Lower Cretaceous, Russia); Cytheridae.

Palaeocytheridea nikitini Liubimova, 1955; p. 38, pl. 5, fig. 8a–c (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea parva Liubimova, 1955; p. 50, pl. 6, fig. 4a–b (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea praerimosa Khabarova, 1955; p. 195, pl. 1, fig. 5 (Middle Jurassic, Russia); Cytheridae.

Palaeocytheridea promta Liubimova, 1955; p. 59, pl. 5, fig. 5a–b (Lower Cretaceous, Russia); Cytheridae.

Palaeocytheridea punctilataeformis Liubimova, 1955; p. 54, pl. 4, fig. 3a–b (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea ramosa Liubimova, 1955; p. 55, pl. 6, fig. 2a–b (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea rara Liubimova, 1955; p. 59, pl. 5, fig. 7a–c (Lower Cretaceous, Russia); Cytheridae.

Palaeocytheridea? reniformis Liubimova, 1955; p. 55, pl. 6, fig. 6a–c (Lower Cretaceous, Russia); Cytheridae.

Palaeocytheridea sokolovi Liubimova, 1955; p. 40, pl. 5, fig. 6a–b (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea tricostata Khabarova, 1955; p. 197, pl. 1, fig. 7 (Middle Jurassic, Russia); Cytheridae.

Palaeocytheridea tuberosa Khabarova, 1955; p. 195, pl. 1, fig. 6 (Middle Jurassic, Russia); Cytheridae.

Palaeocytheridea volema Liubimova, 1955; p. 43, pl. 5, fig. 3a–b (Upper Jurassic, Russia); Cytheridae.

Palaeocytheridea volgaensis Mandelstam, 1955, in Liubimova, 1955; p. 41, pl. 3, fig. 4a–b (Upper Jurassic, Russia); Cytheridae.

Paracypris bellula Liubimova, 1955; p. 22, pl. 1, fig. 4a–b (Upper Jurassic, Russia); Cyprididae.

Paracypris lubrica Liubimova, 1955; p. 24, pl. 1, fig. 5a–b (Upper Jurassic, Russia); Cyprididae.

Paradoxostoma ornata Hartmann, 1954*d*; p. 609, text-fig. 1a–j (Recent, France).

Parapontoparta arcuata Hartmann, 1955; p. 111, text-figs. 1–11 (Recent, Brazil); Cyprididae, Candocyprinae.

Perijonesina sinensis Hou, 1955*a*; pp. 215, 235, pl. 4, figs. 11–19; pl. 5, figs. 1–29; pl. 6, figs. 1–6 (Upper Devonian, Hupeh, China); Kloedenellidae, Cavellininae.

Perimarginia ovata Hou, 1955*a*; pp. 213, 234, pl. 3, figs. 2–3, 12–20; pl. 4, figs. 1–10 (Upper Devonian, Hupeh, China); Kloedenellidae, Cavellininae.

Perimarginia tuberosa Hou, 1955*a*; pp. 212, 232, pl. 2, figs. 1–24; pl. 3, figs. 1, 4–8, 9–11 (Upper Devonian, Hupeh, China); Kloedenellidae, Cavellininae.

Platycythereis baillyensis Stchepinsky, 1955; p. 498, pl. 22, fig. 6, text-pl. 5, fig. 38 (Lower Cretaceous, France); Loxoconchinae.

Polycope arenicola Hartmann, 1954*a*; p. 89, pl. 28, fig. 4a–e; pl. 29, fig. 4f–g (Recent, France); Polycopidae.

Polycope cancellea Hartmann, 1954*a*; p. 84, pls. 24–25, fig. 1a–n (Recent, France); Polycopidae.

Polycope dimorpha Hartmann, 1954*a*; p. 95, pl. 32, fig. 8a–n (Recent, Italy); Polycopidae.

Polycope elongata Hartmann, 1954*a*; p. 97, pl. 33, fig. 1a–i (Recent, Sylt, a German island in the North Sea); Polycopidae.

Polycope levis Hartmann, 1954*b*; p. 175, text-figs. 1–14 (Recent, Brazil); Polycopidae.

Polycope limbata Hartmann, 1954*a*; p. 87, pl. 27, fig. 3a–f; pl. 28, fig. 3g–k (Recent, France); Polycopidae.

Polycope longipes Hartmann, 1954*a*; p. 91, pl. 30, fig. 6a–f; pl. 34, fig. 6g–i (Recent, France); Polycopidae.

Polycope marci Hartmann, 1954*b*; p. 178, text-figs. 15–22 (Recent, Brazil); Polycopidae.

Polycope microdispar Hartmann, 1954*a*; p. 85, pl. 26, fig. 2a–h (Recent, France); Polycopidae.

Polycope obtusa Hartmann, 1954*a*; p. 96, pl. 34, fig. 10a–c (Recent, Italy); Polycopidae.

Polycope onkophora Hartmann, 1954*a*; p. 90, pl. 29, fig. 5a–g (Recent, France); Polycopidae.

Polycope ramosa Hartmann, 1954*a*; p. 93, pl. 31, fig. 7a–i (Recent, Italy); Polycopidae.

Polytylites simplex Hou, 1954; pp. 234, 254, pl. 1, fig. 8a–b (Lower Permian, Hupeh, China); Kirkbyidae.

Pontocypris arcuata Liubimova, 1955; p. 19, pl. 1, fig. 1a–b (Upper Jurassic, Russia); Cyprididae.

Pontocyprella aureola Liubimova, 1955; p. 20, pl. 1, fig. 2a–b (Upper Jurassic, Russia); Cyprididae.

Primitia ichangensis Hou, 1953*b*; pp. 70, 76, pl. 1, fig. 2a–c (Lower Ordovician, Hupeh, China); Primitiidae.

Primitia? nanmanensis Hou, 1953*a*; pp. 40, 44, pl. 1, figs. 1–2 (Lower Ordovician, Liaotung, China); Primitiidae.

Primitia quadrata Hou, 1955*a*; pp. 208, 228, pl. 1, figs. 10–12, 14–17 (Upper Devonian, Hupeh, China); Primitiidae.

Primitia subfurcata Hou, 1953*b*; pp. 70, 76, pl. 1, fig. 3a–b (Lower Ordovician, Hupeh, China); Primitiidae.

Primitia tumiduformis Hou, 1953*b*; pp. 69, 76, pl. 1, fig. 1a–b (Lower Ordovician, Hupeh, China); Primitiidae.

Primitia yungchunensis Hou, 1955*b*; pp. 310, 314; pl. 1, figs. 9–11 (Middle Devonian, Yungchun, Kwangsi, China); Primitiidae.

Procytheropteron obesum Liubimova, 1955; p. 68, pl. 7, fig. 6a–b (Upper Jurassic, Russia); Cytheridae.

Protoargilloecia impurata Liubimova, 1955; p. 25, pl. 1, fig. 6a–b (Middle and Upper Jurassic, Russia); Cyprididae.

Protocythere attalica Mandelstam, 1955, in Liubimova, 1955; p. 73, pl. 8, fig. 3a–b (Upper Jurassic, Russia); Protocytherinae.

Protocythere attendens Liubimova, 1955; p. 74, pl. 9, fig. 2a–b (Upper Jurassic, Russia).
Protocythere catephracta Mandelstam, 1955, in Liubimova, 1955; p. 70, pl. 8, fig. 4a–b (Upper Jurassic, Russia); Protocytherinae.
Protocythere cavernosa Liubimova, 1955; p. 84, pl. 9, fig. 8a–b (Upper Jurassic, Russia); Protocytherinae.
Protocythere clivosa Khabarova, 1955; p. 193, pl. 1, fig. 4 (Middle Jurassic, Russia); Cytheridae.
Protocythere cornulateralis Liubimova, 1955; p. 78, pl. 8, fig. 7a–b (Upper Jurassic, Russia); Protocytherinae.
Protocythere dulcis Liubimova, 1955; p. 75, pl. 8, fig. 8a–b (Upper Jurassic, Russia); Protocytherinae.
Protocythere egregia Liubimova, 1955; p. 81, pl. 9, fig. 4a–b (Upper Jurassic, Russia); Protocytherinae.
Protocythere fistulosa Liubimova, 1955; p. 83, pl. 9, fig. 7a–b (Upper Jurassic, Russia); Protocytherinae.
Protocythere furssenkoi Liubimova, 1955; p. 85, pl. 10, fig. 1a–b (Lower Cretaceous, Russia); Protocytherinae.
Protocythere juncta Liubimova, 1955; p. 82, pl. 9, fig. 5a–b (Upper Jurassic, Russia); Protocytherinae.
Protocythere karpinskyi Mandelstam, 1955, in Liubimova, 1955; p. 71, pl. 8, fig. 5a–b (Upper Jurassic, Russia); Protocytherinae.
Protocythere limata Liubimova, 1955; p. 82, pl. 9, fig. 6a–b (Upper Jurassic, Russia); Protocytherinae.
Protocythere nitida Liubimova, 1955; p. 79, pl. 9, fig. 3a–c (Upper Jurassic, Russia); Protocytherinae.
Protocythere pavlovi Liubimova, 1955; p. 70, pl. 9, fig. 1a–c (Upper Jurassic, Russia); Protocytherinae.
Protocythere rubra Mandelstam, 1955, in Liubimova, 1955; p. 72, pl. 8, fig. 6a–b (Upper Jurassic, Russia); Protocytherinae.
Protocythere strigatus Khabarova, 1955; p. 194, pl. 1, fig. 1a–b (Middle Jurassic, Russia); Cytheridae.
Protocythere verrucifera Liubimova, 1955; p. 78, pl. 9, fig. 9a–b (Upper Jurassic, Russia); Protocytherinae.
Richterina subhemisphaerica Hou, 1955*b*; pp. 311, 315, pl. 1, figs. 1–5 (Upper Devonian, Lingchuan, Kwangsi, China); Entomozoidae.
Richterina substriatula Hou, 1955*b*; pp. 311, 315, pl. 1, figs. 6–8 (Upper Devonian, Lingchuan, Kwangsi, China); Entomozoidae.
Roundyella ovatiformis Hou, 1954; pp. 236, 256, pl. 1, fig. 11 (Lower Permian, Hupeh, China); Kirkbyidae.
Semilukiella arcuata Egorov, 1950; p. 38, pl. 4, figs. 27–38 (Upper Devonian, Russia); Kloedenellidae.
Semilukiella grandis Egorov, 1950; p. 39, pl. 4, figs. 22–26 (Upper Devonian, Russia); Kloedenellidae.
Semilukiella zaspelovae Egorov, 1950; p. 36, pl. 4, figs. 1–21 (Upper Devonian, Russia); Kloedenellidae.
Sinoprimitia hupeiensis Hou, 1953*b*; pp. 72, 78, pl. 1, fig. 5a–b (Lower Ordovician, Hupeh, China); Primitiidae.
Sinoprimitia sinensis Hou, 1953*b*; pp. 71, 77, pl. 1, fig. 4a–b (Lower Ordovician, Hupeh, China); Primitiidae.
Sulcocavellina incognita Egorov, 1950; p. 118, pl. 7, figs. 1–13 (Upper Devonian, Russia); Kloedenellidae.
Thalassocypris elongata Hartmann, 1955; p. 115, text-figs. 12–23 (Recent, Brazil); Cyprididae, Candocyprinae.
Timanella typica Egorov, 1950; p. 120, pl. 7, figs. 33–39 (Upper Devonian, Russia); Kloedenellidae.
Tricornina (*Bohemina*) *prantli* Sňajdr, 1951; p. 205, pl. 1, figs. 1–4 (Middle Devonian, Czechoslovakia); Hollinidae, Ctenentominae.
Trinota constata Hou, 1955*a*; pp. 222, 242, pl. 8, figs. 22–26 (Upper Devonian, Hupeh, China); family uncertain.
Uchtovia elongata (Glebovskaia and Zaspelova in litt.), in Egorov, 1950; p. 42, pl. 6, figs. 1–39 (Upper Devonian, Russia); Kloedenellidae.
Uchtovia polenovae Egorov, 1950; p. 41, pl. 5, figs. 14–35 (Upper Devonian, Russia); Kloedenellidae.
Xestoleberis costata Hartmann, 1954*c*; p. 243, text-fig. 3a–i (Recent, Majorca).
Xestoleberis delamarei Hartmann, 1954*c*; p. 241, text-fig. 2a–k (Recent, France).
Xestoleberis fuscata Schneider, 1953; pp. 108–109, pl. 4, fig. 7 (Middle Miocene, western Ukraine).

SUPPLEMENT TO FORMS WITH NOMENCLATURA APERTA 1950–1955

Bairdia sp., Hou, 1955*a*; pp. 220, 240, pl. 9, figs. 9–10 (Upper Devonian, Hupeh, China); Bairdiidae.
Bairdia sp. *A*, Hou, 1954; pp. 239, 260, pl. 2, fig. 6a–b (Lower Permian, Hupeh, China); Bairdiidae.
Bairdia sp. *B*, Hou, 1954; pp. 240, 261, pl. 2, fig. 7a–b (Lower Permian, Hupeh, China); Bairdiidae.
Bairdia sp. *C*, Hou, 1954; pp. 240, 261, pl. 2, fig. 8 (Lower Permian, Hupeh, China); Bairdiidae.
Bairdia sp. *D*, Hou, 1954; pp. 240, 261, pl. 1, fig. 15 (Lower Permian, Hupeh, China); Bairdiidae.
Bernix? sp., Hou, 1955*a*; pp. 222, 242, pl. 8, figs. 27–37 (Upper Devonian, Hupeh, China); family uncertain.
Healdia sp., Hou, 1955*b*; pp. 310, 314, pl. 1, fig. 14 (Upper Devonian, Lingchuan, Kwangsi, China); Healdiidae.
Knoxiella? sp., Hou, 1955*a*; pp. 219, 239, pl. 7, figs. 1, 9–15 (Upper Devonian, Hupeh, China); Kloedenellidae.
Macrocypris sp., Hou, 1954; pp. 240, 263, pl. 2, fig. 9a–b (Lower Permian, Hupeh, China); Bairdiidae.
Mennerella? sp., Hou, 1955*a*; pp. 209, 230, pl. 1, figs. 26–30 (Upper Devonian, Hupeh, China); Kloedenellidae, Kloedenellinae.
Genus and species *A* (indet.), Hou, 1955*a*; pp. 223, 243, pl. 1, figs. 18–20 (Upper Devonian, Hupeh, China); family uncertain.
Genus and species *B* (indet.), Hou, 1955*a*; pp. 224, 243, pl. 1, figs. 1–9, 13 (Upper Devonian, Hupeh, China); family uncertain.
Genus and species (indet.), Hou, 1954; pp. 243, 264, pl. 2, fig. 12a–d (Lower Permian, Hupeh, China).
Genus and species (indet.), Hou, 1955*b*; p. 312, pl. 1, figs. 12–13 (Upper Devonian, Lingchuan, Kwangsi, China).

ABSTRACT: *Investigations by Bolli, Ericson, and others have shown that changes in the direction of coiling noted throughout the time-range of certain pelagic foraminifera can be used in stratigraphic correlation. Such changes have also been noted in a species of* Globorotalia *occurring commonly in West Pakistan, in which an abrupt change from left to right coiling and back again to left coiling occurs near the Lower Eocene/Palaeocene boundary.*

Direction of coiling in Globorotalia as an aid in correlation

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INTRODUCTION

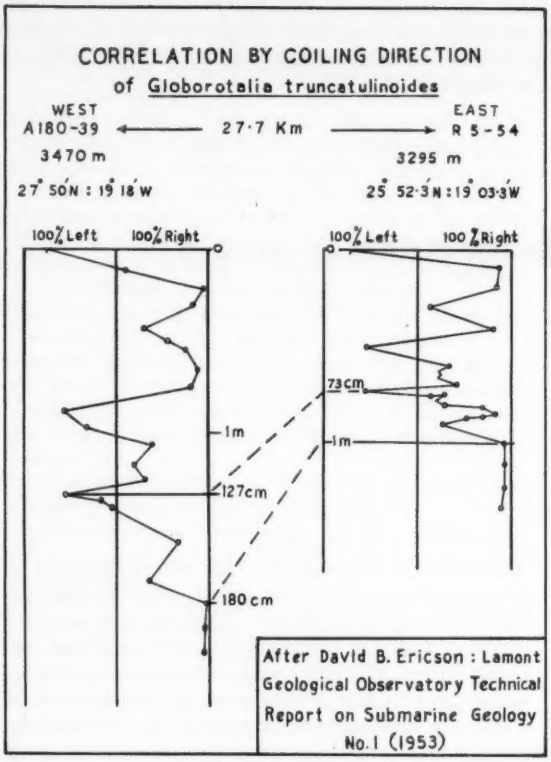
In a recent paper, Bolli (1950) reported the results of his investigations on the direction of coiling of certain species of *Globorotalia* and *Globotruncana* from the Cretaceous and Tertiary of Trinidad. He showed that the direction of coiling changes, during the period of existence of some species, from random coiling (roughly 50 per cent dextral and 50 per cent sinistral) in the early stages to predominantly left or right coiling (95 to 100 per cent dextral or sinistral, depending upon the particular species) in the later stages. Further, he demonstrated the existence of more complex changes in some species of *Globorotalia*, in which the predominant direction of coiling is changed with scarcely any transition, although a reversion to the originally preferred direction usually takes place after a short stratigraphic interval. It has been suggested that such a morphogenetic series, when firmly established and directly correlated with stratigraphic occurrence, will contribute considerably to the determination of the relative stratigraphic position of unknown samples (Bronnimann, 1951). If, as has been suggested, these changes in the coiling characters of a species can be correlated with stratigraphic positions or ranges, their value as an aid in stratigraphic correlation becomes immediately apparent.

APPLICATION TO RECENT AND SUB-RECENT SEDIMENTS

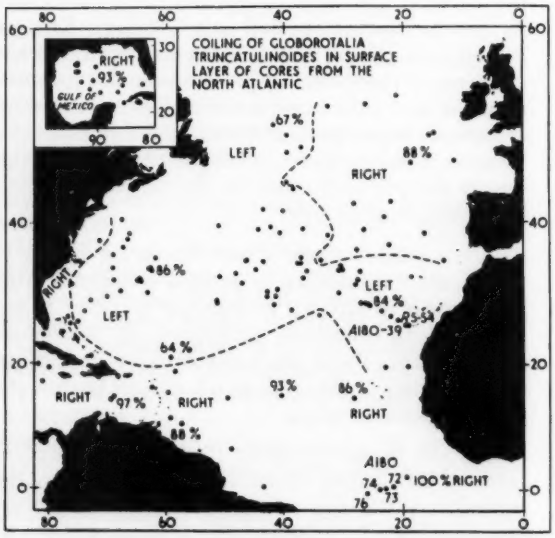
Use has been made of such changes in the direction of coiling in *Globorotalia truncatulinoides* (d'Orbigny) and *Globorotalia menardii* (d'Orbigny) (Ericson, 1953; Ericson and Wollin, 1956*b*) in correlating deep-sea cores from the North Atlantic. In two cores taken nearly 28 km. apart, about 360 km. southwest of Tenerife, Canary Islands, the curves showing the proportions of right to left coiling shells of *Globorotalia* can be matched perfectly. Both sections are composed of uniform foraminiferal lutite, without sand or silt layers. The cores were ideal because there was no serious mixing of layers by burrowing animals, and there were no winnowed layers at the shallower station. It is obvious from these curves that the upper 180 cm. of section in core no. A 180–39 is the time equivalent of the upper 100 cm. in core no. R 5–54 (text-fig. 1). Using this method, Ericson successfully correlated several other deep-sea sections in the Atlantic. There are apparently great possibilities for this method in applied palaeontology. Ericson, Wollin and Wollin (1955) have demonstrated the existence of three distinct provinces in the Atlantic, of which the central one shows predominantly sinistrally coiled specimens of *Globorotalia truncatulinoides*, whereas in the northern and southern provinces, this species shows a preference for dextral coiling. Their conclusion is of interest:

"Since we know little about the living habits of planktonic foraminifera in general it appears futile at this time to attempt to conceive a theory to explain coiling direction preference in *Globorotalia truncatulinoides*. There are, however, a few deductions from evidence in the cores which at least narrow the range of possible causes.

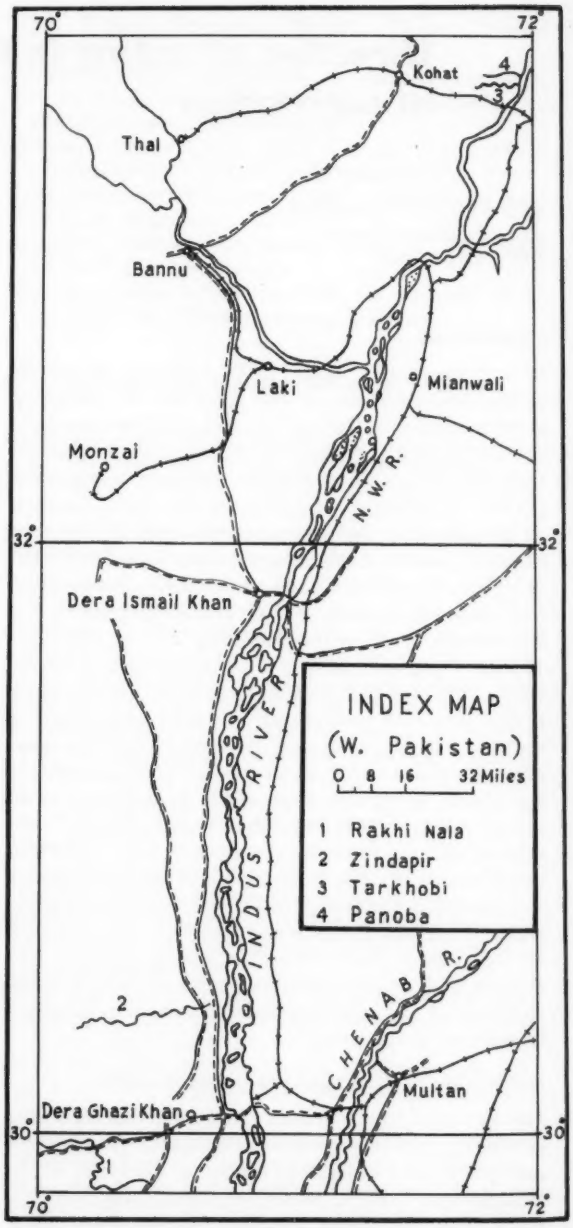
"From the thickness, about 10 cm., of the Recent layer of left coiling dominance in cores from the central zone it is apparent that the left coiling province has been in existence for at least as long as 2,000 years and probably a good deal longer. At the



TEXT-FIGURE 1



TEXT-FIGURE 2
(After Ericson, Wollin and Wollin, 1955.)



TEXT-FIGURE 3

same time we know from the equatorial cores that the southern right coiling province has existed continuously for at least some tens of thousands of years. Now, not only is there no physical barrier between the provinces but distribution of the species is in fact continuous from one province to the next. In 2,000 years, in the absence of any other influence, mixing of populations by oceanic circulation and diffusion ought to have taken place. Since this has not happened we conclude that coiling direction dominance must somehow be maintained by selection or some environmental factor favouring one direction in preference to the other.

"This conclusion is not inconsistent with Bolli's finding that there is a secular trend in the life of a species which leads from randomness to strong dominance of one coiling direction throughout its geographical range. *Globorotalia truncatulinoides* is a relatively young species. Some indecision as to its coiling direction is expectable. In sharp contrast is the old species, *Globorotalia menardii* (d'Orbigny), which has attained a very high ratio of left coiling. . . . More likely, as with *G. truncatulinoides*, there is, and has been, something about the environment which strongly favours survival of those individuals of the species having a particular coiling direction. . . .

"From the coiling curves of *G. truncatulinoides* it is evident that left coiling dominance has been exceptional during the late Pleistocene. It is also clear that the central province of left coiling has come into existence in Recent time, that is during the last ten thousand years. In what way have conditions in this wide region of the North Atlantic become exceptional? Perhaps the answer to this question is somehow bound up with the instability of the Recent climate.

"In the meantime, these coiling ratios may be put to use in measuring relative rates of accumulation, and thereby may reveal processes of deposition otherwise rather difficult to detect."

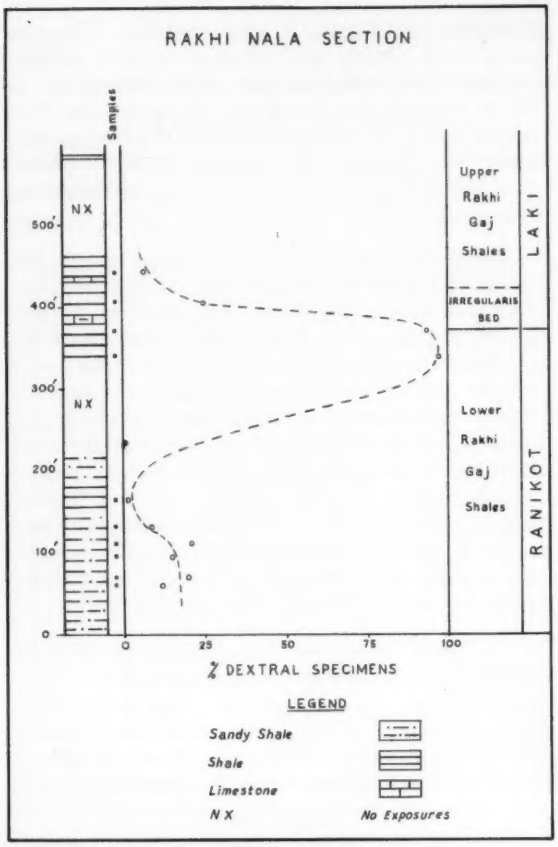
APPLICATION IN WEST PAKISTAN

Soon after Bolli published the results of his investigations, an attempt was made in our palaeontological laboratory to determine whether or not a species of *Globorotalia* occurring commonly in the Palaeocene and Lower Eocene rocks of West Pakistan showed any peculiarities in the direction of coiling throughout its stratigraphic range. In the Ranikot and Laki succession (Palaeocene to Lower Eocene) of northeastern Baluchistan and the Kohat district of West Pakistan, a species of *Globorotalia* which is probably related to *Globorotalia velascoensis* Cushman and Ponton is very common. The proportions of dextral and sinistral tests in samples coming from several sections were determined, as far as possible, on counts of 100 specimens. The results, which are here published by the kind permission of the Burmah Oil Company Limited, proved most interesting, as can be seen from the following discussion.

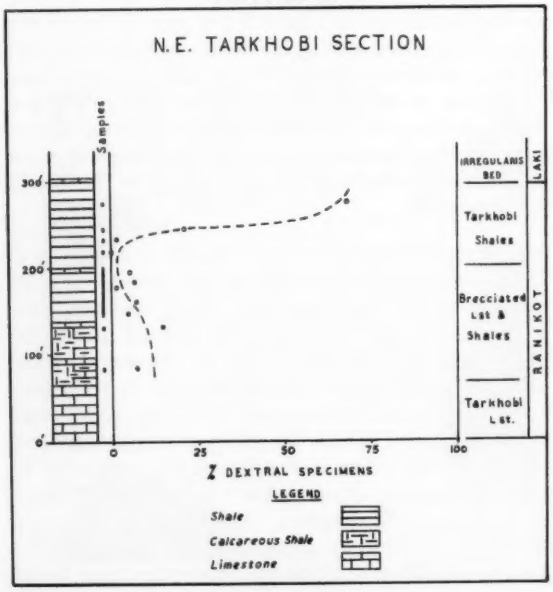
In the Rakhi Nala section (see index map), this species of *Globorotalia* occurs with fair frequency in the lower Rakhi Gaj shales and continues up into the base of the upper Rakhi Gaj shales, above the Irregularis bed (see pl. 1, fig. 1). In the lower samples the species is only 12 per cent dextrally coiled; there is then a rather large sampling gap, and above it the coiling is 95 per cent dextral; above the Irregularis bed, the species then swings back to predominantly sinistral coiling. In the highest sample, the proportion of dextrally coiled specimens is only 6 per cent. This behaviour closely resembles that of *Globorotalia menardii* (d'Orbigny) and *Globorotalia aragonensis* (Nuttall) described by Bolli.

In the Zinda Pir section the same species of *Globorotalia* ranges from the Zinda Pir shales into the lower part of the Ghazij shales (see pl. 1, figs. 2–3). In the Zinda Pir shales the numbers of dextral and sinistral specimens are rather erratic, but there is a definite tendency toward a lower figure for dextral specimens (approximately 25 per cent). In the next higher subdivision, the Zinda Pir limestone, this low dextral tendency is much more pronounced, and dextral coiling is reduced to about 5 per cent. Toward the top of this group and in the basal part of the Ghazij shales, however, there is an abrupt temporary swingover to 92 per cent or more dextrally coiled forms, followed by a return, in the remaining higher samples, to a low dextral tendency comparable with that found throughout the major part of the Zinda Pir limestone.

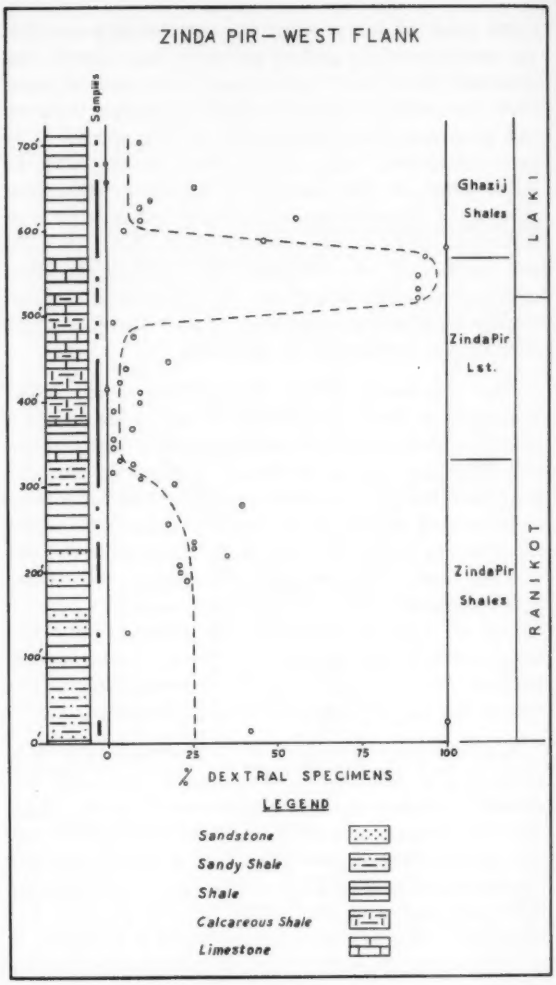
In the northeastern Tarkhobi section, this species of *Globorotalia* occurs throughout the greater part of the brecciated limestones and shales and the Tarkhobi shales, but does not quite extend up to the Irregularis bed (see pl. 1, fig. 4). Throughout the brecciated limestones and shales, and in the lower half of the Tarkhobi shales, there are 7 per cent dextrally coiled forms. In the next higher sample, there appears to be a significant change, with 22 per cent dextral, although the total number of specimens is only thirty-seven. In the highest sample available, there is an increase to 69 per cent dextrally coiled forms, although again the total count (only sixteen) is small.



TEXT-FIGURE 4



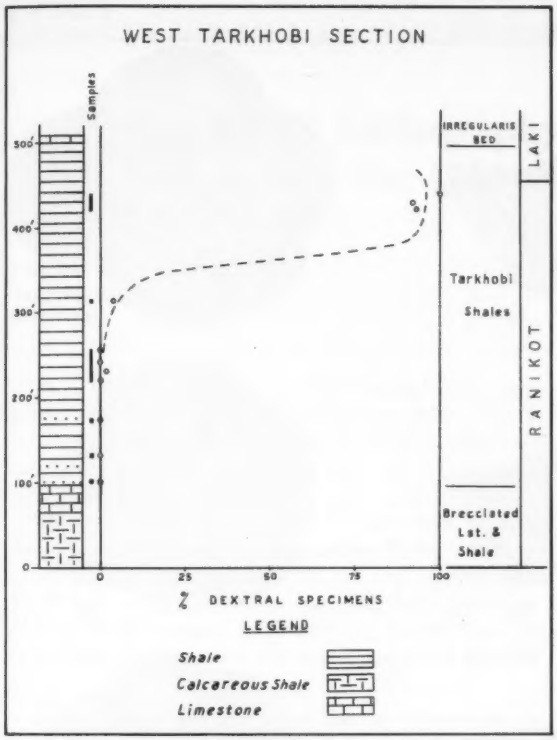
TEXT-FIGURE 6



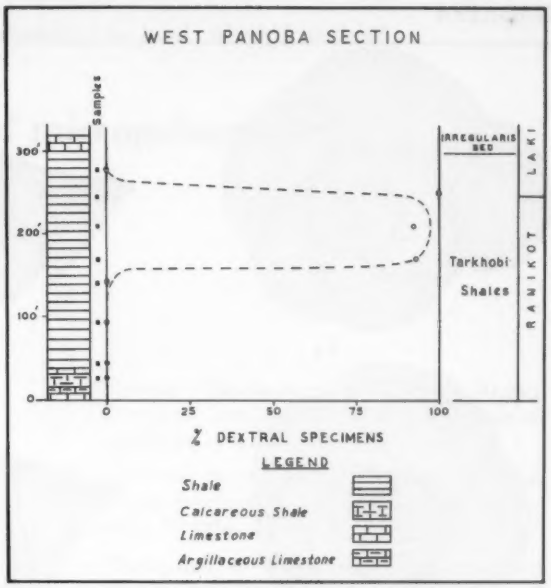
TEXT-FIGURE 5

In the western Tarkhobi section also, the range of this species of *Globorotalia* does not extend up to the Irregularis bed. In the lower half of the Tarkhobi shales, dextral coiling is of very low frequency (in a number of samples the specimens are 100 per cent sinistral), but in the three samples from the upper half of this subdivision, the proportion of dextral specimens is quite high, varying from 92 to 100 per cent. In both the northeastern Tarkhobi section and the western Tarkhobi section, higher horizons of the succession are not represented.

In the western Panoba section, in which the major part of the Tarkhobi shales is exposed, the lower samples show a 100 per cent sinistral preference. The higher samples show 93 to 100 per cent dextral forms. In the highest sample in which this species is found, the count is only four specimens, all of which



TEXT-FIGURE 7



TEXT-FIGURE 8

are sinistral. It seems probable, therefore, that the pattern of Rakhi Nala is repeated in the Kohat area, over an almost identical range.

The significance of this behaviour with regard to the direction of coiling in this species of *Globorotalia* will become evident when it is realized that in all the localities mentioned above, the swingover from a low dextral percentage to almost 100 per cent dextral and then back again to low dextral takes place in the vicinity of the Laki/Ranikot boundary. This knowledge cannot be used where the succession is all limestone, because it has been found that extraction of free specimens from such limestones is difficult. In most such cases, however, the larger foraminiferal faunas, which can be studied in thin sections, show sufficient differences in the assemblages to define the Laki/Ranikot boundary. On the other hand, where the succession is all argillaceous, the change in the direction of coiling in this species of *Globorotalia* provides a simple, independent means of determining this boundary.

From the investigations carried out so far, it seems clear that instability in the direction of coiling is probably common in the early period within the evolutionary time-span of a species. There is probably a preferred direction of coiling for every species, right or left as the case may be, to which it ultimately gravitates. Whatever conditions bring about these changes in the direction of coiling, their practical value in correlation is apparent, and although scientific curiosity will perhaps eventually lead to an explanation of the phenomenon, the stratigraphic palaeontologist is meanwhile content to make use of the results.

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1950 – *The direction of coiling in the evolution of some Globorotaliidae.* Cushman Found. Foram. Res., Contr., vol. 1, pts. 3–4, pp. 82–89, pl. 15, text-figs. 1–5, tables 1–2.

BRONNIMANN, P.
1951 – *News report – West Indies.* Micropaleontologist, vol. 5, no. 1, pp. 3–5.

ERICSON, D. B.
1953 – *Sediments of the Atlantic Ocean.* Columbia Univ., Lamont Geol. Observ., Tech. Rept., no. 1, pp. 2–34, text-figs. 1–6 (mimeo.).

ERICSON, D. B., AND WOLLIN, G.
1956*a* *Correlation of six cores from the equatorial Atlantic and the Caribbean.* Deep-Sea Res., vol. 3, no. 2, pp. 104–125, text-figs. 1–11, tables 1–6.

1956*b* *Micropaleontological and isotopic determinations of Pleistocene climate.* Micropaleontology, vol. 2, no. 3, pp. 257–270, text-figs. 1–7, tables 1–5.

ERICSON, D. B., WOLLIN, G., AND WOLLIN, J.
1955 – *Coiling direction of Globorotalia truncatulinoides in deep-sea cores.* Deep-Sea Res., vol. 2, no. 2, pp. 152–158, pl. 1, text-figs. 2–4.

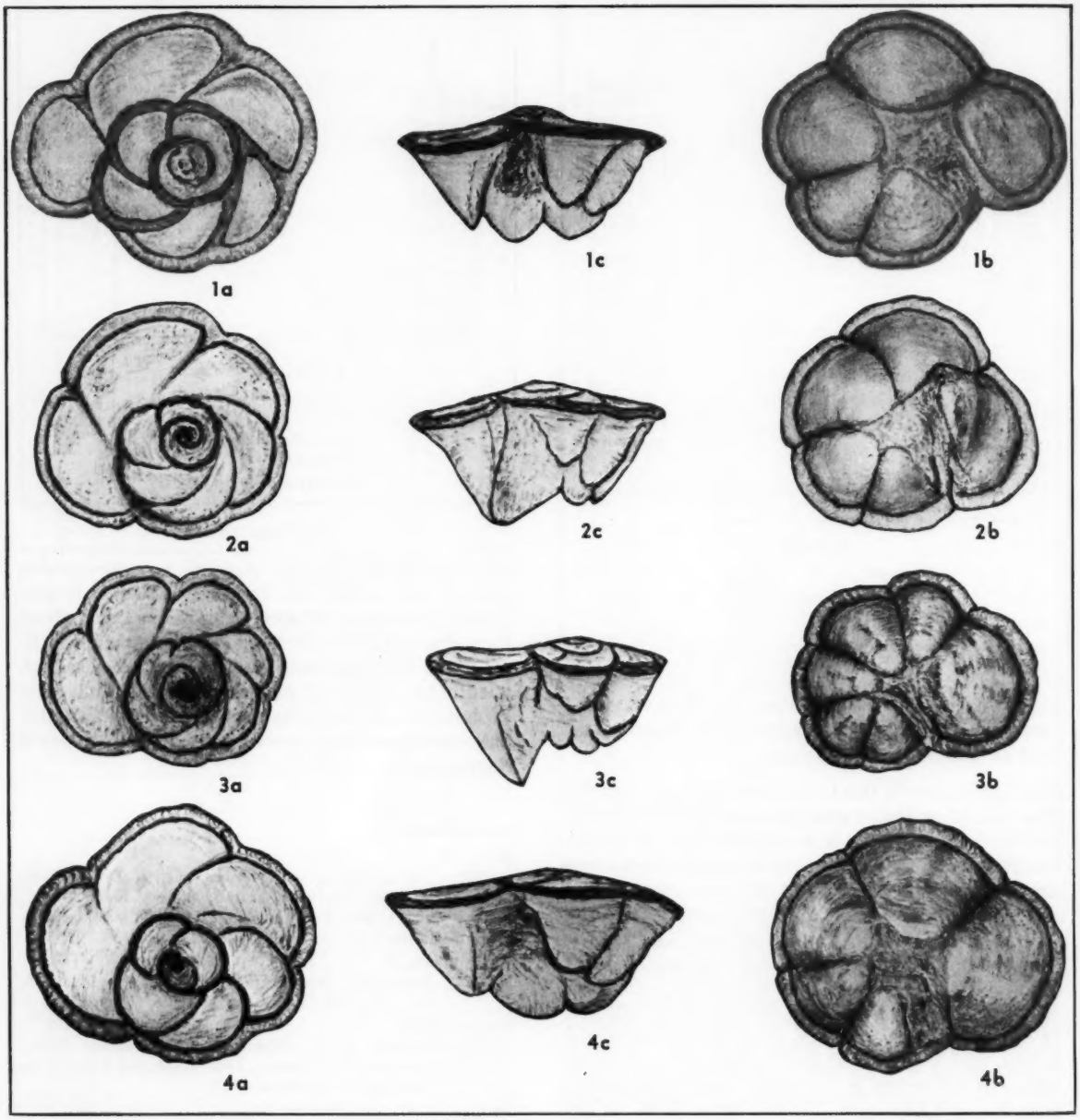

PLATE 1

All figures × 90.

1 *Globorotalia* sp.
a, dorsal view; b, ventral view; c, side view. Rakhi Nala section.

2 *Globorotalia* sp.
a, dorsal view; b, ventral view; c, side view. Zinda Pir section.

3 *Globorotalia* sp.
a, dorsal view; b, ventral view; c, side view. Zinda Pir section.

4 *Globorotalia* sp.
a, dorsal view; b, ventral view; c, side view. Tarkhobi section.

ABSTRACT: *One hundred twelve papers on all fields of micropaleontology are listed and briefly reviewed.*

Annotated bibliography of micropaleontology in Germany for 1956

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This is the continuation of the bibliography published last year in Micropaleontology (1956, vol. 2, no. 4, pp. 385–392). As before, it is again restricted to papers that are concerned with micropaleontology and microstratigraphy or that mention microscopic fossils. In addition to foraminifera, micropaleontology comprises ostracodes, Radiolaria and other animal microfossils, as well as microscopic fragments of larger organisms and fossil plant remains. In the present bibliography, papers that are important in taxonomy are marked with an asterisk.

ATZBACH, O., AND GEIB, K. W.
1955 – *Über einen neuen Fundpunkt im Unteren Meeressand (Mitteloligozän) bei Bretzenheim/Nahe (Mainzer Becken).* Hessen, Landesamt Bodenf., Notizbl., vol. 83, pp. 237–242, 2 text-figs.

Names of seven foraminifera (determined by K. Stolz) from the upper Rupelian.

BARTENSTEIN, H.
1956 – *Zur Mikrofauna des englischen Hauterive.* Senckenbergiana Lethaea, vol. 37, pp. 509–533, 3 pls., 4 text-figs.

Figures and descriptions of forty-five foraminifera and eight ostracodes, including two new species of each, in a sample from Lincolnshire.

BETTENSTAEDT, F., AND WICHER, C. A.
1955 – *Stratigraphic correlation of Upper Cretaceous and Lower Cretaceous in the Tethys and Boreal by the aid of microfossils.* World Petrol. Congress, IV (Rome), Proc., Sect. I/D, no. 5, pp. 493–516, 3 pls., 2 tables.

Vertical-range tables of twenty-five Lower Cretaceous and thirty-eight Upper Cretaceous small foraminifera in the Boreal and Tethys regions all over the world, on the assumption that the nomenclature is uniform.

BISCHOFF, G.
1956 – *Das Profil Amönau bei Marburg und das Alter der "Buchenauer-Schichten" auf Grund von Conodonten.* Hessen, Landesamt Bodenf., Notizbl., vol. 83, pp. 126–131.

Various "Buchenauer Schichten" (Upper Devonian) can be distinguished by means of conodonts of different ages.

*1956 – *Oberdevonische Conodonten (to I δ) aus dem Rheinischen Schiefergebirge.* Hessen, Landesamt Bodenf., Notizbl., vol. 84, pp. 115–137, pls. 8–10.

Description of Upper Devonian conodont faunas; includes seventy-one species, among which four are new; subdivision into three zones.

BISCHOFF, G., AND ZIEGLER, W.
*1956 – *Das Alter der "Urfer Schichten" im Marburger Hinterland nach Conodonten.* Hessen, Landesamt Bodenf., Notizbl., vol. 84, pp. 138–169, 4 pls., 1 table.

Stratigraphic determinations on the basis of conodonts, covering Devonian and Carboniferous limestones from twenty localities. A total of 121 forms were distinguished, representing twenty-five genera, eighteen of which are found in both the Devonian and the Carboniferous, and sixteen in the Carboniferous only.

BRELIE, G. VON DER
1956 – *Diatomeen als Fazies-Fossilien.* Geol. Rundschau, vol. 45, pp. 84–97, 2 text-figs.

Ecologic and stratigraphic conclusions based on diatoms from nine borings through the Holocene and Pleistocene.

BRELIE, G. VON DER, AND REIN, U.
1956 – *Die Möglichkeiten pollenanalytischer Orientierung in mächtigen Flözen am Beispiel des rheinischen Hauptflözes in der Ville und in der Schachtanlage Morschenich.* Zeitschr. Braunkohle, vol. 8, pp. 209–219, 10 text-figs.

Application of palynological methods in the detailed stratigraphy of Tertiary brown-coal seams, with specific examples.

DAHM, H. D.
1956 – *Diatomeenuntersuchungen zur Geschichte der westlichen Ostsee.* Meyniana, vol. 5, pp. 7–50, 11 text-figs., 8 pls., 2 tables.

List of 305 diatoms obtained from boring samples for stratigraphic evaluation. Oscillations of the salinity and the water table.

DIEBEL, K.

1956 – *Über Trias-Conodonten.* Geologie, vol. 5, pp. 9–12.

Discovery of conodonts in the Triassic, mostly associated with fish remains (abstract in Pal. Zeitschr., vol. 30, p. 19).

*1956 – *Conodonten in der Oberkreide von Kamerun.* Geologie, vol. 5, pp. 424–440, 6 pls., 2 text-figs.

Two Turonian samples from the Mungo River contained more than 200 conodonts, which are described and figured. They belong to ten genera, and include *Polygnathus mungoensis*, n. sp., and *Apatognathus ziegleri*, n. sp.

FIEBIG, H., AND GREBE, H.

1956 – *Die fazielle und stratigraphische Bedeutung der Mikrofauna im Ruhrkarbon und ihr praktischer Wert für den Bergbau.* Deutsch. Geol. Ges., Zeitschr., vol. 107, pp. 284–285.

Brief reference to stratigraphically important microfossils in the Carboniferous of the Ruhr (abstract).

GANSS, O., AND KNIPSCHEER, H. C. G.

1956 – *Die Maastricht-Eozän-Folge des Helveticums im Sprunggraben bei Oberteisendorf (Obb.) und ihre Gliederung mit Hilfe pelagischer Foraminiferen.* Geol. Jahrb., vol. 71, pp. 617–630, 1 table.

Lists of foraminifera from seven samples from the Cretaceous-Tertiary transition. Discussion of the vertical ranges of fifteen pelagic foraminifera, with a table.

1956 – *Nochmals: Zur Altersstellung der Nierentaler Schichten.* Neues Jahrb. Geol. Pal., Monatshefte, pp. 290–297.

Classification of the Gosau beds as upper Coniacian to lower Campanian, and of the Nierental beds as lower Campanian to Maestrichtian.

GANSS, O., AND OTHERS

1956 – *Geologie des Blattes Bergen.* Geologica Bavarica, no. 26, 164 pp., 1 pl., 7 text-figs., 5 tables, 1 map.

A vertical-range table, microstratigraphic classifications, and lists of Upper Cretaceous and Tertiary foraminifera of the Kalk-Alpes and Helveticum and of the Molasse.

GOERLICH, F.

1956 – *Mikropaläontologische und stratigraphische Untersuchungen im Königreich Yemen.* Pal. Zeitschr., vol. 30, pp. 213–214.

Brief note on Pliocene and Quaternary foraminifera and ostracodes.

GRELL, K. G.

1956 – *Morphologie und Entwicklungsgeschichte der Protozoen.* Fortschritte der Zoologie, new ser., vol. 10, pp. 1–31.

Pages 13 to 15 concern foraminifera, with special reference to Le Calvez. Sex determination is indicated genotypically and phenotypically. Both generations may have proloculi of equal size.

*1956 – *Der Kerndualismus der Foraminifere Glabratella sulcata.* Zeitschr. Naturf., vol. 11, pt. B, pp. 366–368, 2 text-figs.

Cultivation of *Glabratella sulcata* resulted in a regular alternation of two distinct generations.

HAGN, H.

*1956 – *Geologische und paläontologische Untersuchungen im Tertiär des Monte Brione und seiner Umgebung (Gardasee, Ober-Italien).* Palaeontographica, vol. 107, pt. A, pp. 67–210, 12 pls., 8 text-figs.

Description of 201 small foraminifera, among which sixteen species and two subspecies are new. They were found in a sample taken from a few meters of Upper Eocene *Globigerina* marl from Varignano. Discussion of Maestrichtian, Cuisian, Lutetian, Ledian, Priabonian, Lattorfian(?), Rupelian, Chattian and Aquitanian beds on the basis of thin sections.

HAGN, H., AND BARTHEL, K. W.

1956 – *Neuere Erfahrungen mit Polestar bei präparativen Arbeiten.* Pal. Zeitschr., vol. 30, pp. 207–212, 1 pl.

The use of Polestar resin for thin sections. This resin hardens in the absence of heat, and is heat resistant.

HÄNTZSCHEL, W.

1956 – *Rückschau auf die paläontologischen und neontologischen Ergebnisse der Forschungsanstalt "Senckenberg am Meer."* Senckenbergiana Lethaea, vol. 37, pp. 319–330.

Reference to previously published findings on Recent foraminifera (p. 326).

HARTMANN, G.

*1955 – *Neue marine Ostracoden der Familie Cypridae und der Subfamilie Cytherideinae der Familie Cytheridae aus Brasilien.* Zool. Anzeiger, vol. 154, pp. 109–154, 44 text-figs.

Descriptions of three genera, two of which are new, comprising five species; special attention is given to the appendages.

*1955 – *Zur Morphologie der Polycopiden.* Zeitschr. Wiss. Zool., vol. 158, pp. 193–248, 43 text-figs.

Monographic revision of these ostracodes, which range in size from 0.14 to 0.7 mm., with reference to the appendages and surface sculpture. Geological considerations.

*1956 – *Weitere neue marine Ostracoden aus Brasilien.* Beitr. zur neotropischen Fauna, Jena, vol. 1, pp. 19–62, 111 text-figs.

Descriptions of fourteen species of *Mesocythere, Leptocythere, Cythereis, Loxoconcha, Paradoxostoma, Cytherura,* and *Sclerochilus.* One genus and six species are new.

1956 – *Zur Kenntnis des Mangrove-Estero-Gebietes von El Salvador und seiner Ostrakodenfauna.* Kieler Meeresf., vol. 12, pp. 219–248, 3 pls., 1 table.

Indications of the substrata, salinity, temperatures, currents, and vegetation in the tidal regions and estuaries, with reference to the ostracodes.

HASEMANN, W., AND HEINEMANN, W.

1956 – *Mitteloligozän (Rupelien) an der Ostseite des Kaiserstuhls.* Baden, Landesver. Naturk., Mitt., new ser., vol. 6, pp. 228–230.

Short list of autochthonous and allochthonous foraminifera.

HAVLENA, V.

1956 – *Reste karbonischer Pilze und Folgen ihrer Zersetzungstätigkeit an Megasporen und Kutikulen.* Pal. Zeitschr., vol. 30, pp. 163–168, 2 pls., 1 text-fig.

Mushrooms decompose to form principally carbonaceous spores.

HILTERMANN, H.

1956 – *News report – Germany.* Micropaleontology, vol. 2, no. 2, pp. 194–196.

References to various meetings, excursions and lectures having some bearing on microstratigraphy and micropaleontology.

1956 – *Biostratigraphie der Oberkreide auf Grund von Mikrofossilien.* Pal. Zeitschr., vol. 30, suppl., pp. 19–32, 6 text-figs.

Small foraminifera are used for subdivision of the stages of the Upper Cretaceous. Comparison of their vertical ranges in northwestern Germany with those in other regions.

1956 – *Ten rules concerning the nomenclature and classification of the foraminifera.* Micropaleontology, vol. 2, pp. 296–297.

Species represent the most objective taxonomic unit; their description is required.

1956 – *Annotated bibliography of micropaleontology in Germany for 1955.* Micropaleontology, vol. 2, pp. 385–392.

There are eighty-nine entries, with annotations concerning stratigraphy and bionomy of foraminifera, ostracodes, pollen and spores, conodonts, and Bryozoa.

1956 – *Mikropaläontologische Arbeitsmethoden in den Vereinigten Staaten von Amerika.* Erdöl und Kohle, vol. 9, pp. 750–753, 1 text-fig.

Remarks on the training of students; on nannofossils; on ecology; and on methods of making opaque shells transparent.

HILTERMANN, H., AND KOCH, W.

*1956 – *Mikropaläontologische Feinhorizontierung von Santon-Profilen durch das Erzlager Lengede-Broistedt.* Pal. Zeitschr., vol. 30, suppl., pp. 33–44, 3 pls., 6 text-figs.

Vertical ranges of twelve foraminifera in the Santonian portion of an ore deposit, with a maximum thickness of 10 meters; its subdivision into seven bionomic zones; description of *Anomalina (Gavellinella) sculptilis,* n. sp.

HOFKER, J.

*1956 – *Die Globotruncanen von Nordwest-Deutschland und Holland.* Neues Jahrb. Geol. Pal., Abh., vol. 103, pp. 312–340, 26 text-figs.

Differentiation of ten species, six of which are new, belonging to the genera *Thalmanninella, Rotalipora, Globotruncana* and *Marginotruncana,* n. gen.; none of these genera is believed to be related to the Globigerinidae. The value of *Globotruncana* and related forms in long-range correlation is restricted.

*1956 – *Die Pseudotextularia-Zone in der Bohrung Maasbüll I, und ihre Foraminiferen-Fauna.* Pal. Zeitschr., vol. 30, suppl., pp. 59–79, 6 pls., 1 text-fig.

Brief descriptions and drawings of seventy foraminifera, among which nine species and one subspecies are new. They were derived from the upper Maestrichtian of Schleswig. An attempt is made to compare these foraminifera with those of Denmark, Egypt and Israel.

HORST, U.

1956 – *Sporomorphen und andere Stabilprotobitumina als stratigraphische Hilfsmittel bei der Flözgleichstellung im erzgebirgischen Steinkohlenbecken.* Freiberger Forschungshefte, vol. C 3, pp. 66–82, 3 pls., 7 text-figs.

Discussion of stratigraphic applications of plant remains, with forty-eight photographs of isolated sporangia wall-cells, mega- and microspores.

HUCKRIEDE, R.

1955 – *Conodonten in der mediterranen Trias.* Austria, Geol. Bundesanst., Verh., no. 4, pp. 260–264.

Reference to conodonts in Triassic limestones of the Alps, Bosnia and Asia Minor; they appear to be absent in the Mediterranean Jurassic.

INDANS, J.

1956 – *Zur mikropaläontologischen Gliederungen des Oligozäns in der Bohrung Kühlerhof bei Erkelenz.* Neues Jahrb. Geol. Pal., Monatsh., pp. 173–184, 6 text-figs.

Vertical-range table, and four faunal photographs, of thirty-seven foraminifera from a boring through 220 meters of Oligocene beds in the Lower Rhine region.

JESSEN, W.
1956 – *Cyclotherme der Ruhrkarbons und ihre Fauna und Flora.* Deutsch. Geol. Ges., Zeitschr., vol. 107, pp. 295–310.

Brief reference to microfossils from an outcrop of the Westphalian A.

JOSTEN, K. H.
1956 – *Die Kohlen im Pfälzer Bergland.* Hessen, Landesamt Bodenf., Notizbl., vol. 84, pp. 300–327, pls. 20–22, 10 text-figs., 6 tables.

In addition to petrographic details concerning Upper Carboniferous and Lower Permian coals, generic names of eleven spores are given.

KIESEL-NASIADEK, Y.
1956 – *Die Foraminiferen des Turons von Pirna.* Min. Geol. Jahrb., Dresden, vol. 1, pp. 24–58, 1 pl., 2 text-figs.

A total of 135 species, some with open nomenclature, are listed from seventy-two samples from thirty-nine localities. In the Turonian, with a thickness of 200 meters, the vertical and horizontal distribution of foraminifera is a function of facies.

KIRCHHEIMER, F.
1956 – *Die Karpolithen-Kohle von Salzhausen im Vogelsberg.* Hessen, Landesamt Bodenf., Notizbl., vol. 83, pp. 47–71, pls. 3–4, 2 text-figs.

List of eleven pollen forms found in Upper Tertiary brown coal.

KLASZ, I. DE
1956 – *Zur Kenntnis der ostalpinen Oberkreidestratigraphie.* Neues Jahrb. Geol. Pal., Monatshefte, pp. 410–419.

Correction of some previous microstratigraphic determinations and of the definition of *Globotruncana andori.*

KLINGLER, W.
1956 – *Zur Gliederung des Oberen Malm in Nordwestdeutschland.* Erdöl und Kohle, no. 9, pp. 578–579, 1 table.

Table of vertical ranges of twenty-four ostracodes, and microstratigraphic delimitation of the Gigas beds, the Eimbeckhäuser platy limestone, the Münder marl, and the Serpulite.

KNIPSCHEER, H. C. G.
1956 – *Biostratigraphie in der Oberkreide mit Hilfe der Globotruncanen.* Pal. Zeitschr., vol. 30, suppl., pp. 50–56, 1 pl., 4 text-figs.

Morphogenetic analysis of the group of *Globotruncana elevata* and *Globotruncana stuarti* makes biostratigraphic classification possible from the upper Santonian to the Maestrichtian.

1956 – *Das Alter der Wachauer Schichten bei Wachau.* Neues Jahrb. Geol. Pal., Monatshefte, pp.420–424.

List of foraminifera of Paleocene age.

KNIPSCHEER, H. G. C., TILLMANN, H.
1954 – *Die Oberkreide zwischen Donau und Alpenwand.* In: Erläuterung geol. Karte von Bayern 1:500,000, Munich, pp. 94–95.

Mention of deep borings, and brief reference to biostratigraphic application of *Bolivinoides.*

KÖWING, K.
1956 – *Ausbildung und Gliederung des Miozäns im Raum von Bremen.* Naturw. Ver. Bremen, Abh., vol. 34, pp. 69–171, 17 text-figs., 6 tables.

Petrography and megafossil lists of Miocene outcrops; vertical-range table of ten small foraminifera.

KRÄUZEL, R., AND LESCHIK, G.
*1955 – *Die Keuperflora von Neuewelt bei Basel von G. Leschik.* Schweiz. Pal. Abh., vol. 72, pp. 1–70, 10 pls., 1 text-fig.

Description of numerous spores from six samples of the Schilf sandstone.

KRÄUSEL, W.
*1956 – *Bryozoen-Arten F. A. Roemer's (Fenestellidae) aus dem deutschen Devon.* Senckenbergiana Lethaea, vol. 37, pp. 59–64, 1 pl.

Redescription of six bryozoan species originally described by Roemer.

KRUTZSCH, W.
1956 – *Normapolles im sächsischen Turon.* Dresden, Staatl. Mus. Min. Geol., Jahrb., vol. 2, pp. 125–131, 7 pls.

Photomicrographs and brief descriptions of 201 "archaic" three-cornered pollen forms from the Upper Cretaceous, especially the Turonian.

KSIĄZKIEWICZ, M.
1956 – *Geology of the northern Carpathians.* Geol. Rundschau, vol. 45, pp. 369–411, 12 text-figs.

Summary of present knowledge, with brief references to Upper Cretaceous and Lower Tertiary foraminifera.

KUPFAHL, H.-G.
*1956 – *Zur Variationsbreite einiger Ostracoden der mittleren Adorf-Stufe.* Hessen, Landesamt Bodenf., Notizbl., vol. 84, pp. 21–31, pl. 4, 3 text-figs.

In spite of poor preservation, eleven ostracodes, including three new subspecies of *Waldeckella cicatricosa,* are distinguishable and are used in the stratigraphy of the Upper Devonian near Marburg.

LANGE, W.

1956 – *Grundproben aus Skagerrak und Kattegat, mikrofaunistisch und sedimentpetrographisch untersucht.* Meyniana, vol. 5, pp. 51–86, 2 pls., 3 text-figs., 5 tables.

Determinations of depth, stratification, foraminifera, ostracodes, petrography, and salinity of thirteen bottom samples and one Kullenberg core 9 meters in length.

LESCHIK, G.

1956 – *Die Entstehung der Braunkohle der Wetterau und ihre Mikro- und Makroflora.* Palaeontographica, vol. 100, pt. B, pp. 26–64, 5 pls., 4 tables.

Description of plant remains taken from three Upper Pliocene sections above the basalts; twenty-four newly discovered pollen and microspore forms are named, and eighty-nine forms are figured, among which five species are new.

*1956 – *Sporen aus dem Salzton des Zechsteins von Neuhof (bei Fulda).* Palaeontographica, vol. 100, pt. B, pp. 123–142, 3 pls.

Technical methods are described; qualitative analysis of thirty-five micro- and isospores shows mainly anemophilous forms belonging to several genera, including *Cordaites* and Sigillariaceae (abstract in Pal. Zeitschr., vol. 30, p. 18).

MÄDLER, K.

1956 – *Pollenanalytische Untersuchungen im Posidonienschiefer.* Pal. Zeitschr., vol. 30, p. 18.

Abstract, with remarks on techniques.

1956 – *A technique for the preparation of multi-grain palynological slides.* Micropaleontology, vol. 2, pp. 399–401, 1 text-fig.

Multigrain preparations containing 100 objects on one slide simplify techniques of preparation.

MATTHES, H. W.

1956 – *Einführung in die Mikropaläontologie.* Leipzig: 348 pp., 197 pls., tables.

Brief introduction; part 1 (239 pp.) covers the systematic classification of thirty fossil groups, especially foraminifera and ostracodes; part 2 consists of microstratigraphic tables; part 3 (9 pp.) covers general micropaleontology; part 4 (10 pp.) describes methods; there is an index of 23 pages.

MERTENS, E.

*1956 – *Zur Grenzziehung Alb/Cenoman in Nordwestdeutschland mit Hilfe von Ostracoden.* Geol. Jahrb., vol. 72, pp. 173–230, 7 pls., 1 table.

Descriptions and figures of fifteen ostracode genera comprising twenty-four species; four genera and eleven species are new. They were derived from 641 samples from the Albian and Cenomanian of northwestern Germany. A vertical-range table is given.

MEYER, B. L.

*1956 – *Mikrofloristische Untersuchungen an jungtertiären Braunkohlen im östlichen Bayern.* Geol. Bavarica, no. 25, pp. 100–129, 5 pls., 2 text-figs., 2 tables.

Palynology of ten brown-coal occurrences; the older coal contains the microflora of the Miocene/Oligocene transition of the Rhineland; the younger brown coal seems to be younger than the Rhenanian Miocene. Descriptions and figures of seventy-one pollen species, among which are two new species of *Monoporopollenites*, n. gen.

MOOS, B.

1956 – *Zur Struktur, Entwicklung und Nomenklatur des Schlosses jurassischer Ostracoden nach Sylvester-Bradley.* Erdöl und Kohle, vol. 9, pp. 832–834, 2 text-figs.

Summary of the terminology compiled by Sylvester-Bradley (1956, British Mus. (Nat. Hist.), Bull., Geol., vol. 3).

MÜLLER, A. H.

1956 – *Zur genaueren Kenntnis von Lophidiaster pygmaeus (Astereozoa) aus der Schreibkreide (Maastricht) von Rügen.* Geologie, vol. 5, pp. 642–647, 2 text-figs.

Descriptions, figures and discussion of isolated skeletal elements.

MÜLLER, K. J.

*1956 – *Zur Kenntnis der Conodonten-Fauna des europäischen Devons; 1 – Die Gattung Palmatolepis.* Senckenb. Naturf. Ges., Abh., no. 494, pp. 1–70, 11 pls., 1 text-fig., 2 tables.

Evaluation of 4400 conodonts recovered from 115 limestone samples by means of acetic acid (15%). Revision of *Palmatolepis*, with description of three subgenera. Morphologic analysis of twenty-seven species, fifteen of which are new. References to equivalent forms found in America, to stratigraphy, to associated fossils, and to bionomy of various European localities.

MÜLLER, M.

1956 – *Ein Beitrag zur holozänen Emstalentwicklung zwischen Meppen und Dörpen auf Grund von pollenanalytischen Untersuchungen.* Geol. Jahrb., vol. 71, pp. 491–504, 6 text-figs., 1 table.

Applications of pollen analysis in a study on the course of the River Ems during the Holocene.

MÜRRIGER, F., AND PFLANZL, G.

1956 – *Pollenanalytische Datierungen einiger hessischen Braunkohlen.* Hessen, Landesamt Bodenf., Notizbl., vol. 83, pp. 71–90, pls. 5–6, 1 table.

Summary of palynological determinations, with photographs of twenty-three pollen forms, seven of which are new.

OHM, P., AND REMMERT, H.

1955 – *Études sur les Rockpools des Pyrénées-Orientales.* Vie et Milieu, vol. 6, pp. 194–209, 5 text-figs.

Reference to two *Heterocypris* species.

PAPP, A.

1956 – *Die morphologisch-genetische Entwicklung von Orbitoiden und ihre stratigraphische Bedeutung im Senon.* Pal. Zeitschr., vol. 30, suppl., pp. 45–49, 2 text-figs.

Reference and morphogenetic table of *Orbitoides* and *Lepidorbitoides* in the Campanian and Maestrichtian.

PARSCH, K. O. A.

*1956 – *Die Serpuliden-Fauna des südwestdeutschen Jura.* Palaeontographica, vol. 107, pt. A, pp. 211–240, 3 pls., 1 text-fig., 3 tables.

Descriptions and vertical ranges of fifty species of *Serpula*, eleven of which are new, derived from 900 samples from seventy-two Jurassic localities.

1955 – *Das zeitliche Auftreten der Serpuliden (Tubicole Anneliden).* Hessen, Landesamt Bodenf., Notizbl., vol. 83, pp. 44–46, 1 table.

Note on the vertical ranges of serpulid genera.

PFLANZL, G.

*1956 – *Das Alter der Braunkohlen des Meißners, der Flöze 2 und 3 des Hirschberges und eines benachbarten Kohlenlagers bei Laudenbach.* Hessen, Landesamt Bodenf., Notizbl., vol. 84, pp. 232–244, pls. 16–17, 1 table.

Palynology of various kinds of Tertiary brown coal in Hessen, with figures of twenty-eight pollen species, six of which are new.

POTONIÉ, R.

1956 – *Über die Behandlung der Sporae dispersae und der fossilen Pflanzen überhaupt nach dem Internationalen Code der botanischen Nomenklatur.* Pal. Zeitschr., vol. 30, pp. 69–87.

Compilation of those portions of the International Code that are important in the nomenclature of isolated spores.

1956 – *Die stratigraphische Inkongruität der Organe des Pflanzenkörpers.* Pal. Zeitschr., vol. 30, pp. 88–94.

In fossil plants, the name of the organ species is stratigraphically more important than the name of the synthetic species.

*1956 – *Synopsis der Gattung der Sporae dispersae; Teil 1 – Sporites.* Geol. Jahrb., Beiheft no. 23, 103 pp., 11 pls.

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Examination of a thin section of a dolomite breccia. Seven foraminifera recognized. *Plectogyra* and *Nummulostegina* indicate a Lower Carboniferous rather than a Cambrian age, as formerly supposed.

ZIEGLER, W.
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Descriptions and figures of nine genera comprising twenty-two forms of Lower Devonian conodonts from the Harz, Kellerwald, and Marburg region. Five new names are proposed.

ABSTRACT: *A two-chambered microfossil with an internal tube and elongate neck is here described as* Draffania biloba, *n. gen., n. sp. It most resembles the Charophyta, but its actual relationships are unknown. It is confined to a narrow horizon in the upper Visean of Scotland and England.*

A problematic new microfossil from the Scottish Lower Carboniferous

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University of Glasgow

Amongst the microfossils of the Scottish Lower Carboniferous there occur a large number of forms whose exact zoological or botanical affinities are unknown. Some appear to have distinct stratigraphic value, and this is especially true of a new form first discovered in calcareous shales associated with the Dockra limestone at Draffan, near Lesmahagow. This has been identified as a persistent and often abundant fossil confined to the lower part of the Lower Limestone Group and the uppermost layers of the Calciferous Sandstone Series in the Scottish Lower Carboniferous. Outside the Midland Valley, it has been found at equivalent horizons in England and in Ireland.

This problematic microfossil is here named *Draffania biloba* Cummings, gen. et sp. nov., and described below.

MICROFOSSIL INCERTAE SEDIS

Draffania Cummings, **gen. nov.**

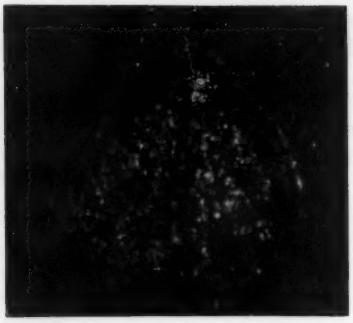
Type species: Draffania biloba Cummings, *sp. nov.* (here designated).

Description: Test small, flask-shaped or pyriform, consisting of two hemispherical chambers arranged on either side of a thin, delicate tube, which is extended into a neck of variable length; surface smooth or faintly and minutely reticulate, and often covered with minute pore openings; periphery rounded; wall calcareous, perforate, and relatively thick, with layered structure; apertural opening circular, terminal, at the end of the elongate neck.

Range: Lower Carboniferous.

Draffania biloba Cummings, **sp. nov.**
Text-figures 1–9

Description: Test small, pyriform, sacciform or flask-shaped, with well-rounded base and elongate neck, and subcircular to ellipsoidal in cross-section; consisting of two hemispherical chambers, laterally arranged about a delicate median internal tube, with their adjacent surfaces flattened; one chamber of slightly greater volume than the other; the boundary between them shown externally by two broad, shallow, depressed sutural areas aligned in the same plane as the elongate neck; laterally these sutural areas are well-defined, but they become vague in the basal region, where there may be a slight spinose projection in a central position; periphery smoothly and broadly rounded, with a tendency for one lateral surface to be less inflated than the other; surface relatively smooth, with numerous regularly arranged fine, distinct perforations, which often exhibit a spiral pattern but which are almost entirely absent in the sutural areas; test wall relatively thick, calcareous, and homogeneous, with numerous radially arranged perforations and with indications of an original layered structure, the latter shown externally on weathered tests as indistinct ribbing running slightly oblique to the plane of the sutural areas; aperture small, circular, terminal, on an elongate neck, and internally linked to the chambers by a fine, delicate tube composed of fibrous calcareous material; this tube lies in the plane of the sutural areas and extends down to a central position on the adjacent chamber surfaces, where it divides into two, one branch piercing laterally into each of the chambers. In thin section, this form is readily identified by its two-chambered organisation and its thick, perforate, layered calcareous wall (see text-figures 7–9).



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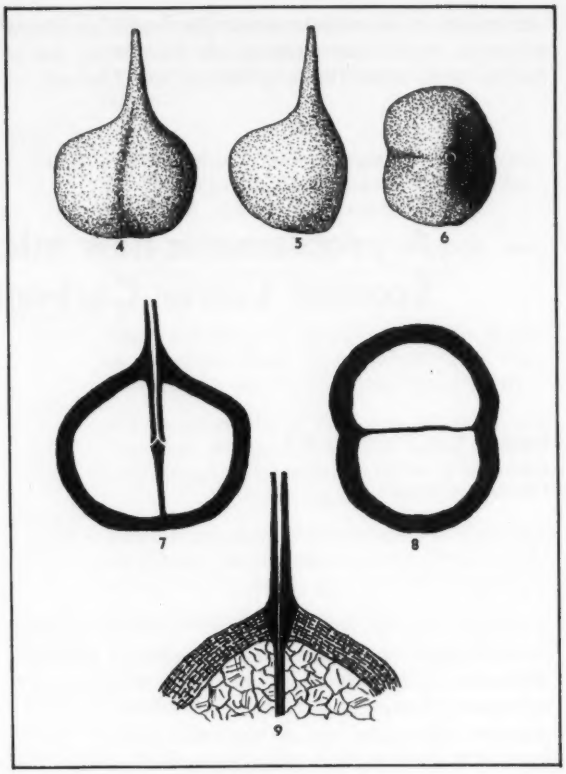
TEXT-FIGURES 1–3

Draffania biloba Cummings, gen. nov., sp. nov.: 1, paratype, thin section, × 45; slide no. 11315, H.M. Geol. Survey; 2, holotype, lateral view, × 50; slide no. 11322, H.M. Geol. Survey; 3, steinkern in silica, lateral view, × 35; slide no. 11530, H.M. Geol. Survey.

Dimensions: Maximum width of holotype 0.75 mm.; maximum breadth 0.65 mm.; maximum height 0.85 mm.; length of neck 0.25 mm.; width of neck at aperture 0.1 mm.; thickness of outer wall 0.06–0.12 mm.; diameter of internal tube 0.02 mm.; average thickness of wall of internal tube 0.005 mm.

Depository: Holotype (slide no. 11322) and figured paratype, thin-section (slide no. 11315), in the Reserve and Study Collection, H.M. Geological Survey, Edinburgh Office, from the shales above the Dockra limestone, Lower Limestone Group, Lower Carboniferous, of Draffan, near Lesmahagow, Lanarkshire, Scotland. Figured specimen (slide no. 11530) in the same Reserve and Study Collection, from the upper part of the Broadstone limestone, Lower Carboniferous, of Crawfield, near Kilbirnie, Ayrshire, Scotland.

Comparison and affinities: The bilobed character of *Draffania*, with the two distinct and separate chambers sharing a common tube to the aperture, shows that it cannot be referred to the foraminifera or other protozoans, despite the fact that a flask-shaped test is common in these groups. The nature of the test wall, the bilobed structure, the minute reticulation of the surface, and the stalk-like neck composed of fibrous calcite, all



4 5 6 7 8 9

TEXT-FIGURES 4–9

Structure of *Draffania biloba* Cummings, gen. nov., sp. nov.: 4, lateral view, × 45, showing broad sutural area; 5, side view, × 45, showing asymmetry of test; 6, apertural view, × 45; 7, vertical section (diagrammatic), × 55, showing internal tube and connection to chambers; 8, horizontal transverse section (diagrammatic), × 70, showing thick chamber walls and thin internal partition below tube; 9, detailed structure of the neck region, × 90, showing fibrous tube (black), layered chamber wall, and steinkern of calcite. Diagrams based on camera-lucida drawings of paratype material.

exhibited by *Draffania*, are common features of the pedicellariae of the Echinodermata. Geis (1936) recognised the occurrence and stratigraphic value of pedicellariae in the Upper Palaeozoic, and from many of the Scottish localities where *Draffania* occurs there are records of Echinodermata. These include *Archaeocidaris scotica* Young and *Archaeocidaris urei* Fleming. This problematic form might be interpreted, therefore, as primitive globiferous pedicellariae, acting as mucous glands in Upper Palaeozoic echinoids in the same way as those described in other fossil and Recent forms by Sladen (1880) and by Prouho (1890). Such a hypothesis seems unlikely, however, when it is considered that valvular and prehensile structures, essential in pedicellarian functioning, are totally lacking in *Draffania*.

There are certain similarities between *Draffania* and certain structural features of the plant kingdom. Thus, its bilobed character and elongate neck are analogous in form to several sporangia in the higher plants, such as the Filicales or the Pteridospermae, which are known to occur as fossils in the Upper Palaeozoic. The wall of *Draffania* is calcareous, however, and its perforate and layered character shows that this condition is not due to secondary calcification during diagenesis. Hence it can be referred only to groups of plants which exhibit primary calcareous investment.

The flask-like shape and perforate condition are common features in the lime-secreting thallophyte group Codiaceae (in such genera as *Ovulites* Lamarck), as well as in the Dasycladaceae ("Siphonae verticillatae"). On the other hand, the bilobed structure is unknown in either of these two groups, and would prove functionally impossible.

A third group of the Thallophyta, the Characeae, possess a pyriform calcareous gyrogonite similar in external characters to *Draffania*. The latter often shows, in worn specimens, a spirally arranged transverse ribbing that closely resembles the spirally arranged enveloping cells of such a charophyte genus as *Trochiliscus*. The perforate and layered nature of the test of *Draffania* is almost identical with that of the trochiliscid oospore membrane. Representatives of the trochiliscids have been recorded from the Devonian of Europe (Croft, 1952), the Upper Carboniferous of Europe and America (Peck, 1934*a*, *b*), and recently from the Scottish Lower Carboniferous (Cummings, MS.). On such grounds, *Draffania* might be considered as a form of trochiliscid. It lacks, however, any structures that might be considered analogous to the node cell, the apical opening, and the coronula, all of which are essential features of the Charophyta. For this reason, its close similarity is noted but its actual inclusion in the Charophyta is withheld.

Preservation and matrix: Draffania biloba usually occurs in calcareous shales, without any major replacement or alteration of structure. In several Ayrshire localities, however, it has been found in the form of steinkerns of the chambers, united in pairs or occurring singly (see text-figure 3). In such instances, the steinkerns are composed of silica, often with a partial or complete covering of ferruginous material, and the host sediment has undergone secondary silicification.

Horizon and facies: This species is found in marine sediments throughout the British Lower Carboniferous areas, especially in limestones and calcareous shales. It is confined to a relatively small stratigraphic interval within the upper Visean, and shows little variation of form within the sequence.

In Scotland it occurs in the upper part of the Broadstone limestone and in the lower part of the Dockra limestone in Ayrshire, in the lower part of the Hurlet limestone of southern Lanarkshire, and in the upper part of the No. 1 Limestone of Midlothian and Fife. It has also been identified in the limestones of the Liddell Water, Dumfriesshire, which are commonly referred to the uppermost part of the Calciferous Sandstone Series. It occurs at equivalent horizons in the upper Visean limestones of England.

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news reports

BRAZIL

FREDERICO W. LANGE

During the month of May, 1957, your correspondent made a trip from the southern to the northern boundary of Brazil. As he was most fortunate in making contact with nearly all of his colleagues, he is able to give a first-hand account of micropaleontological activities in this country.

Universidade do Rio Grande do Sul
Instituto de Ciências Naturais

Irajá Damiani Pinto is training several assistants in paleontological research. This group is presently engaged in the systematic revision of both Recent and Cretaceous ostracodes and in the identification of Permian ostracodes from Paraná. Ayrton Zingano has begun a palynological research project aimed at correlating the Pennsylvanian coal horizons of Rio Grande do Sul.

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Faculdade de Filosofia, Ciências e Letras

Setembrino Petri has published a paper describing new species of *Tetrataxis* and *Paramillerella* and, in addition, dealing with the stratigraphic distribution of Pennsylvanian foraminifera in the Amazon Basin. Petri has prepared a thesis on Miocene foraminifera from the Pirabas formation of northern Brazil, and is at present engaged in the study of Cretaceous foraminifera from the state of Sergipe.

Departamento Nacional da Produção Mineral
Divisão de Geologia e Mineralogia
Rio de Janeiro

Friedrich W. Sommer had a paper published in the April, 1956, issue of "Micropaleontology," on South American Paleozoic sporomorphs, in which he reached the interesting conclusion that "the microfossils called *Tasmanites* are not a constellation of reproductive particles or spores, but represent a group of micro-organisms deserving systematic independence." He proposed a new family of algae, the Tasmanaceae, for these fossils. In another paper, Sommer described new species of *Tasmanites* from the Devonian of the Tapajós River of Pará. Sommer is now studying additional Silurian and Devonian sporomorphs.

Ivan de Medeiros Tinoco has published a paper on Recent shallow-water foraminifera from Cabo Frio, Rio de Janeiro. A paper on Quaternary foraminifera from Pernambuco is ready for publication. These Recent forms have been investigated especially in order to determine their ecology. Tinoco is now studying Cretaceous and Tertiary foraminifera from northern Brazil.

Petróleo Brasileiro S. A. – Petrobrás

A laboratory is being established in Salvador, Bahia, especially for the analysis of pollen from the Cretaceous of the Recôncavo oil field. Previous work has already shown that pollen can be used with advantage in the correlation of well samples. Drs. Helmut Mueller and Rolf Weber will be in charge of this laboratory.

The laboratory at Belém, Pará, has now been in existence for several years, and has quite adequate equipment. Drs. J. C. Troelsen and Karl Krommelbein are presently in charge, and have the assistance of several laboratory helpers. This laboratory makes sample analyses of cores and cuttings from the various wildcats now being drilled in the Amazon Basin.

Your correspondent is in charge of the Petrobrás laboratory at Ponta Grossa, Paraná. In addition to routine examination of cores and cuttings from wells drilled in southern Brazil, this laboratory is engaged especially in the study of Paleozoic microfossils. So far, a large number of hystrichospherids have been recovered from both the Paraná and the Amazon Basin. Because of their generally long vertical ranges, these microfossils have not proved to be good horizon markers. Some species are useful in the identification of geologic systems, but more commonly, similar species occur in both Silurian and Devonian formations. Some species can be distinguished by statistical methods, but this procedure is too time-consuming for practical purposes. Some Chitinozoa, on the other hand, are very good markers. It has been found that certain species do not exceed a vertical range of 10 or at most 20 meters, even in ditch samples. These same species often have very wide horizontal distribution, and consequently are ideal for stratigraphic correlation. Several papers on these microfossils are now being prepared for future publication.

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Petrobrás
Ponta Grossa, Paraná

FRANCE

JEAN CUVILLIER

Institut Français du Pétrole

In the division of foraminifera and other micro-organisms, M. Lys and Mme. B. Serre have been working mainly on Paleozoic microfaunas, from the Sahara, Montagne Noire, and elsewhere. The study of conodonts has recently been taken up in connection with their work. This branch of micropaleontology is completely new in France. It is expected that considerable time will be devoted to building up card files and collections. Lys is also continuing his studies on the Cretaceous and Tertiary of French West Africa. M. Bourbon is specializing in Jurassic microfaunas, and is also occupied with perfecting laboratory techniques.

In the division of ostracodes, N. Grékoff has published a practical guide to the post-Paleozoic ostracodes (*Guide pratique pour la détermination des ostracodes post-Paléozoïques*. 1956, ed. Technip). In addition, he has been studying ostracodes from the Mesozoic of the Belgian Congo. In collaboration with G. Deroo, Grékoff has published a paper on Cretaceous ostracodes from Spain (1956, Estud. Géol., no. 31–32). As a member of the committee on the Maestrichtian, Deroo has been concentrating particularly upon the revision of that stage. Deroo also completed a paper on the Lower Cretaceous of the Paris Basin (1956, Inst. Franç. Pétrole, Rev., vol. 11, no. 12).

V. Apostolescu is now specializing in Upper Cretaceous and Tertiary forms. He has published several papers concerning these horizons: one on the Upper Cretaceous (1955, Cahiers Géologiques de Thoiry, no. 33), and two on the Tertiary (1956, Cahiers Géologiques, no. 34; and 1956, Inst. Franç. Pétrole, Rev., vol. 11, no. 11). He has also done some work on Jurassic ostracodes.

The palynology section is now directed by B. de Jekhowsky, who succeeded C. Sittler in October, 1955. Sittler left to join the faculty of the University of Strasbourg. In October, 1956, Mme. Magloire also left the I.F.P., to take charge of a laboratory of palynology for the S.P.A.E.F., at Port-Gentil. She was replaced in January, 1957, by Mlle. Lanz. P. Taugourdeau has also been a member of the staff since January, 1957. He specializes in the study of various micro-organisms, such as hystrichospherids, peridinians, and chitinizoans, that are frequently found in association with spores and pollen.

During 1956, the activities of this section centered around the following subjects: The perfection of techniques of preparation; the establishment of card files; and the beginning of the systematic study of hystrichospherids, peridinians, chitinozoans and other micro-organisms. In view of the increase in the staff at the beginning of 1957 to a total of five persons, including technicians, it is hoped that this year it will be possible to concentrate more on basic problems, such as card files, reference collections, and local stratigraphic sections, as well as doing contract work.

In 1956, J. Sigal was put in charge of the division of stratigraphic studies. He has therefore had to direct part of his activities toward subjects that are not specifically micropaleontological in nature. In the field of micropaleontology, however, he has continued his studies of the Cretaceous microfaunas of North Africa (1956, Soc. Hist. Nat. Afrique du Nord, Bull., vol. 47; 1956, Soc. Géol. France, C. R. Somm., no. 3 and no. 8) and of Madagascar (1956, Soc. Géol. France, C. R. Somm., no. 11–12). He has also had occasion to examine Tertiary microfaunas from New Caledonia, and Cretaceous and Tertiary microfaunas from Timor and from the Paris Basin.

Sigal has various papers either in preparation or ready for publication. They include a paper on the microfauna of the Nummulitic of the Alps, written in collaboration with M. Espitalie, of the I.F.P.; one on *Conicospirillina basiliensis* in North Africa, with Mlle. C. Perrot, of the Facultés Catholiques de Lyon; and another on *Microcodium* from the Jura Mountains and the Paris Basin, with Mlle. S. François, of the University of Besançon.

University of Paris
Centre d'Études de Micropaléontologie

During 1956, about fifteen students were working toward their diplomas in "Études Supérieures" in micropaleontology. Ten students were graduated. For the school year 1956–57, about forty students enrolled for the study of micropaleontology. The courses are given under the direction of Professor J. Cuvillier, with the assistance of Mme. Neumann, M. Boulanger, and collaborating specialists such as N. Grékoff for ostracodes and Alpern for palynology. In addition, about fifteen research workers come to the laboratory of micropaleontology to prepare for their diplomas in "Études Supérieures" or to work on their doctoral dissertations. Several of the latter will be completed very soon. These include, for example, Mme. Neumann's revision of the Orbitoididae of the Upper Cretaceous and Eocene of Aquitaine; Wagner's study on Holocene ostracodes from the Netherlands; Alpern's on spores and pollen from oil-bearing formations; D. Boulanger's on the stratigraphy and micropaleontology of the Nummulitic of Landes; and a stratigraphic and micropaleontological revision of the Thanetian of the Paris Basin by Mlle. A. Rouvillois.

Mlle. L. Biot, a technical assistant, is continuing her research on phosphatic chalks from northern France. Mme. LeBlanc is also a technical assistant to Professor Cuvillier, replacing Mlle. Piketty.

The English translation of Cuvillier's "Corrélations stratigraphiques par microfaciès en Aquitaine occidentale" was published in May, 1956 (Leiden: Brill). This book, with about 100 plates and 200 photomicrographs, contains corrections and additions to the French edition of 1951.

Professor Cuvillier presented several papers at the International Geological Congress in Mexico. He is continuing to collect samples of microfacies and microfaunas from various Mediterranean regions. By expanding his collections, he hopes to be able to make more exact stratigraphic correlations in the Mesogean area.

Numerous French and foreign research workers visited the laboratory during the past year, in order to consult the extensive records and collections. It is hoped that new laboratory space will be acquired, making expansion possible. At the end of the previous school year, six students from the laboratory obtained employment with the micropaleontological divisions of oil companies.

École Pratique des Hautes Études, Paris
Laboratory of Micropaleontology

Since its establishment in 1943, this laboratory had been severely crowded in the building of the "Laboratoire d'Évolution des Êtres Organisés," an annex of the Sorbonne. In October, 1956, an additional room in the same building was made available. This will make it possible henceforth to accomodate visitors more comfortably. Working space now can usually be put at the disposal of visiting research workers. This space is presently being used by L. Decloitre, who is working on Recent thecamoebians. Although Decloitre has devoted himself particularly to the fauna of Africa, he is about to undertake a study of the fauna of Iceland, at the request of the publication committee of "The Zoology of Iceland."

J. Deunff, of the geological laboratory of the University of Rennes, who wrote his doctoral dissertation under the direction of G. Deflandre, has been continuing his research on the fossil microplankton of the Devonian of North America. He has published a note on recent advances in our knowledge of Paleozoic microplanktonic biotas with hystrichospherids (1956, Grana Palynologica). Deunff has also discovered interesting remains of ciliates in a chert from Gabon, French Equatorial Africa. L. Valensi has continued his studies on microfossils in chert, concentrating especially on the problem of determining the origins of cherts in section, on the basis of their microfaunas.

Mme. M. Deflandre-Rigaud has published a tentative classification of fossil alcyonarian sclerites (1956, Ann. Pal., vol. 42). She is also continuing her work on the microscopic remains of echinoderms, as well as working on the "Fichier Micropaléontologique." It is expected that another series devoted to the hystrichospherids will be issued in the near future. All species published since the appearance of the previous series on the Hystrichosphaeridea (ser. 3, 1944; ser. 6, 1946; ser. 8, 1946) will be catalogued and illustrated in the forthcoming series. This series will probably be divided into two parts, covering the Paleozoic and the post-Paleozoic species. It will be followed shortly by another series, devoted to the dinoflagellates, which will contain additions to series 1 (1943) and series 5 (1945).

The director of the laboratory, G. Deflandre, and Mme. M. Deflandre-Rigaud have together begun the study of fossil tunicate sclerites, to which they have given the name *Micrascidites* in a preliminary note (1956, Soc. Géol. France, C. R. Somm., no. 4). This note contains the first illustrations of these microfossils. A joint memoir is in preparation.

The Deflandres have established a private laboratory at Forcalquier, Basses-Alpes, a region that is very interesting from a micropaleontological point of view. Mme. Deflandre-Rigaud has begun a study of the cherts of that region,while Deflandre has been studying coccolithophorids and discoasterids from Eocene clays.

On the basis of a detailed study of a diatomite from the Rio Branco area of Brazil, Deflandre has confirmed the conclusions reached by Ruellan concerning the geomorphic evolution of that region. He has also been continuing his studies of Carboniferous Radiolaria, and has discovered several new types in addition to the peculiar genera *Albaillella*, *Ceratoikiscum*, and *Palaeoscenidium*, described previously.

A lively discussion carried on by correspondence between Deflandre and E. Kamptner has finally led to agreement on the systematics and nomenclature to be adopted by Kamptner in the "Treatise on Invertebrate Paleontology." Because Kamptner is describing only the Coccolithophoridae *sensu stricto*, N. Bramlette, of La Jolla, California, has agreed to edit the section on discoasterids and genera of uncertain position. Bramlette plans to visit the École Pratique laboratory in 1957, in order to reach a complete agreement with Deflandre on this subject.

Bureau de Recherches Géologiques, Géophysiques et Minières, Paris

The micropaleontological activities of the B.R.G.G.M. have led to the publication of several papers by P. Marie and his colleagues, on the following subjects:

1) Foraminifera from Cretaceous reef facies, including definitions of new genera belonging to the Valvulinidae and Verneuilinidae (1954, Congr. Géol. Internat., XIX, Algiers, 1952, fasc. 15, sec. 13).

2) New foraminifera from the Upper Cretaceous of Belgium. *Orbignyna lafittei* and *Enantioamphiciryna obesa* were found in the Campanian, and ten other new species in the Maestrichtian (1956, Soc. Géol. Belg., Ann., vol. 70).

3) Fusulinids from Algeria. In addition to the fusulinids, a fauna of smaller foraminifera belonging to the Lituolidae, Textulariidae, Trochamminidae, Placopsilinidae and Miliolidae was found in the oolitic facies (1955, Soc. Géol. France, C. R. Somm., no. 11–12).

4) Miocene foraminifera from Madagascar, showing many characteristics of the Upper Miocene (1955, Soc. Géol. France, C. R. Somm., no. 11–12).

5) A new species of *Austrotrillina* (1955, Soc. Géol. France, Bull., ser. 6, vol. 5).

Mme. LeCalvez has been studying foraminifera from the Pliocene of Corsica. The Pliocene there contains an abundant microfauna of Plaisancian age, hitherto undescribed (1956, Soc. Géol. France, Bull., ser. 6, vol. 6). In collaboration with M. Feugueur, Mme. LeCalvez has presented a preliminary stratigraphic and micropaleontological correlation of the Ypresian of France and Belgium (1956, Soc. Géol. France, Bull., ser. 6, vol. 6).

Compagnie Française des Pétroles
Paris

This laboratory has been active in Paris since the end of 1955. The staff includes four geologists. G. Nouet, chief of the laboratory, and R. Lacassagne, his assistant, concentrate on studies of microfacies and on general planning of the laboratory's work. Mlle. G. Nabos and Mlle. H. Garrot are engaged in studies of microfacies and of free microfaunas of foraminifera and ostracodes. During 1956, 75 per cent of the laboratory's work was for the Bureau d'Études des Bassins, and 25 per cent for the C.F.P. (Normandie).

The work for the Bureau d'Études des Bassins consisted of a study of 5000 samples from Jurassic sections throughout the Paris Basin. Good correlations were obtained by means of microfacies in all parts of the Jurassic, and by means of free microfaunas in the Lias. The principal marker horizons determined by microfacies were that of *Spirillina liassica* at the top of the lower Lias, that of *Kilianina* and *Orbitammina* at the top of the Dogger, that of large trocholines in the lower Callovian, and those of *Discorbis* and of *Pseudocyclammina sequana*, both in the upper Oxfordian. The lower Lias is characterized by a microfaunal association containing *Spirillina liassica* and *Planularia inaequistriata*; the middle Lias, which is very rich in species, by an abundance of Lagenidae; and the upper Lias by an association containing *Citharina flabelloides*, *Pseudocitharina* sp., *Lenticulina d'orbignyi*, and *Reinholdella* sp. All samples from corresponding sections were treated by calcimetry.

In the work for the C.F.P. (Normandie), the general study of the Jurassic of the Paris Basin could be applied in practice. By means of microfacies, it was possible to identify marker horizons in the entire Jurassic as encountered in wells drilled by this company. Interpretations of stratigraphy and of variations in facies could thus be made. In the Upper Jurassic, it was possible to identify zones of characteristic microfaunal associations in both wells and outcrops in Basse-Normandie. Marker horizons in the Lias were also found in three exploratory borings. All cores from the Dogger (the presumed reservoir rock) were studied from the point of view of porosity and permeability, and salinity measurements were taken systematically on the waters obtained in tests of formations. A broad, detailed study of Upper Cretaceous sections in Normandy was also undertaken. It was possible to standardize most of them. Structural mapping can now be carried out on the basis of these results.

University of Dijon
Laboratory of Geology and Micropaleontology

The research studies begun by the various members of this laboratory have either been continued or are on the way to completion. Professor Ciry, director of the laboratory, is completing his study of *Meandropsina*, *Orbitolinopsis*, and related genera. H. Tintant has been continuing his studies of the systematics and ecology of the foraminifera of the Middle and Upper Jurassic of Burgundy (1956, Bull. Sci. Bourgogne, vol. 16), while P. Rat has just finished a paper on the stratigraphy and microfacies of the Cretaceous of northern Spain (1956, 2me Congr. Internat. Études Pyrénéennes, vol. 2, sec. 1). J.-P. Mangin has likewise been continuing his research on the foraminifera of the Nummulitic of the Pyrenees, especially pelagic forms in the "flysch." He is rounding out this work with biometric studies of certain characteristic nummulitids (1956, Acad. Sci., C. R., vol. 242; 1956, 2me Congr. Internat. Études Pyrénéennes, vol. 2, sec. 1) and of foraminifera from the Kimmeridgian of Yonne (1956, Bull. Sci. Bourgogne, vol. 16). Mme. Mangin has begun a revision of the family Miliolidae. She has also been studying associations in the Eocene of Biarritz (1956, Bull. Sci. Bourgogne, vol. 16).

A number of students who are planning to become micropaleontologists have been engaged in various studies: L. Bailloux on miliolids from the Upper Pliocene of Rhodes; F. Doillon on foraminifera from the Adriatic Coast; and J. C. Menot on the Argovian and Rauracian of the "Côte de Beaune" (1956, Faculté des Sciences, Dijon). J. Rabate, micropaleontologist with the C.R. E.P.T., Tunis, spent three months in training at Dijon.

Professor Jan Hofker spent a very interesting week at the laboratory, inaugurating the cycle of his "exchanges of information." The 75th meeting of the Association Française pour l'Avancement des Sciences was held at Dijon in 1956. At Professor Ciry's suggestion, Micropaleontology was host to the Section of Geology. The principal French specialists attended the meetings and presented a number of important papers, which are to be published. Professor Ciry was a member of the French delegation to the 20th International Geological Congress in Mexico. P. Rat represented the laboratory at the international micropaleontological meeting held in England in September, 1956.

Compagnie d'Exploration Pétrolière
Chambourcy, Seine-et-Oise

The new concessions acquired by the company in the Sahara and in the Aquitaine Basin have necessitated an increase in the number of micropaleontologists in the laboratory. The former staff, consisting of Bizon and Mlle. Aurouze, has

been augmented by Mlle. Delisle in the foraminifera section and M. Oertli in the ostracode section. W. Maync also became associated with the company in September, 1956, as a consultant.

Correlations between all of the wells in the Paris Basin have been made. This has made it possible to construct a table in which the principal Jurassic markers (foraminifera and ostracodes) are indicated. Mlle. Aurouze, in collaboration with Bellon, Bizon and Journel, has reported the occurrence of *Kilianina* in the Paris Basin (1956, Soc. Géol. France, Bull., ser. 6, vol. 6). Bernard, Bizon and Oertli have been studying ostracodes from the Bathonian of Poitou (1956, Soc. Géol. France, Bull., ser. 6, vol. 6).

Société Esso de Recherches et d'Exploitation Pétrolières, Bordeaux

The laboratory personnel was augmented at the end of 1956 by the arrival of a young paleontologist, G. Gaudin. Routine work has included study of extension wells in the Parentis area. Exploration has led to the discovery of two new fields, Lugos and Lucats, where the reservoir has been correlated with that of Parentis on the basis of its lithology and paleontology. *Orbitolina*, *Choffatella*, *Dictyoconus*, and *Trocholina* are currently being used for such correlations in the Lower Cretaceous. The Upper Jurassic–Lower Cretaceous contact has been studied, and its position in the stratigraphic column has been determined.

F. Dalbiez has made a stratigraphic study of the Jurassic sequences in the subsurface of northwestern Aquitaine, and has reviewed the stratigraphic distribution of *Cuneolina* (Congr. A.F.A.S., Dijon). M. R. Seronie-Vivien has completed a similar project for the outcropping Jurassic (Congr. A.F.A.S., Dijon). Dalbiez has also published a brief report on micropaleontology in Tunis (Notice explicative carte géologique Tunisie 1/50,000, folio no. 44).

G. Malmoustier has begun a study of calcareous algae. This study has been useful in making stratigraphic and paleoecological interpretations in the Cretaceous. He is also preparing a paper on the Tertiary microfaunas of St.-Geours-de-Marenne, Landes.

Dalbiez and Seronie-Vivien attended the micropaleontological meeting held in England in September, 1956. They heartily support the idea of organizing a similar meeting to be held in the Aquitaine Basin in 1957.

Compagnie Française des Pétroles (Garonne) Bordeaux

The laboratory is under the direction of Dufaure, assisted by Mme. Arnoult. They have been concerned mainly with the following subjects:

Microfacies: (1) Study of the Jurassic on the borders of the Aquitaine Basin; on the northwest, the Vendee-Charente coast (Les Sables d'Olonne and La Rochelle) and the region of Niort; on the east, the edge of the central plateau from the Charente Valley to the Aveyron Valley; and on the southeast and south, the central and eastern Pyrenees. (2) Study of the Neocomian in the vicinity of Nimes, Languedoc, and in the central and eastern Pyrenees (1956, Acad. Sci., C. R., vol. 243). (3) A detailed study of the Cenomanian in the northwestern part of the Aquitaine Basin, in the Île d'Oléron and Saintes sector.

Macrofaunas: Identification of ammonites collected from the Jurassic of the Aquitaine Basin and from the Lower Cretaceous of Languedoc.

Microfaunas: Preliminary investigations: (1) Census of ostracodes and foraminifera in the Jurassic of the northwestern area. (2) Study of the ostracodes in the Eocene-Oligocene sequences in the Bergerac sector.

Société Nationale des Pétroles d'Aquitaine Laboratory at Pau, Basses-Pyrenees

This laboratory is directed by Debourle, with Deloffre as assistant. Deloffre left for military service in November, 1956, and has been replaced by Mlle. Rolland.

During the past year, the laboratory staff has studied numerous samples from sections systematically measured by M. Henry in the front ranges of the northern Pyrenees. These sections include formations ranging in age from Liassic to Aptian. The results of these studies have strongly modified the ideas previously held concerning these horizons. The laboratory's work has also contributed largely to the success of mapping operations designed to clarify the stratigraphy and structure of the Upper Cretaceous flysch.

In so far as possible, Debourle has continued his revision of the microfaunas and microfacies of the formations at the Cretaceous/Tertiary boundary. Toward the end of 1956, the laboratory began work on the first material to come in from the Basses-Alpes concession.

Société Nationale des Pétroles d'Aquitaine Laboratory at Maxeville, Meurthe-et-Moselle

This laboratory is under the direction of M. Delmas, assisted by M. Cabrit. The staff has been carrying on a study of micro-organisms, mainly foraminifera, from the lower Bajocian to the Sequanian of the eastern part of the Paris Basin. The results of this study have been summarized in a table showing the stratigraphic distribution of the species, with illustrations and descriptions. The Bathonian horizons have been studied more intensively. In addition to *Kilianina* sp. and *Orbitammina elliptica*, some species and genera that are apparently related to the Meandropsinidae have been noted (Bull. Sci. Bourgogne, in press).

A preliminary study of the ostracodes occurring from the Lias to the Upper Jurassic in the same region has also been undertaken. A few species, notably those of the genera *Lophocythere* and *Pleurocythere*, seem to make very precise subdivision possible in the marly zone of the Bathonian, which underlies the Callovian-Oxfordian marls. Considerable similarity to the ostracode faunas of Germany has been noted. The use of subspecies seems to be feasible for fine stratigraphic subdivision in certain zones.

Régie Autonome des Pétroles Saint-Gaudens

Under the direction of V. Pérébaskine, the central laboratory at Saint-Gaudens has continued to carry on paleontological and micropaleontological studies of cores and surface samples from various concessions in France (1955, Inst. Franç. Pétrole, Rev., vol. 10, no. 5) and in the Sahara (C.R.E.P.S.). The age of the samples ranges from pre-Cambrian to Tertiary. The laboratory staff has also made detailed studies of microfaunas in washed samples and thin sections, principally from Mesozoic formations encountered in wells drilled in Aquitaine, and from material sent in by the C.R.E.P.S. A micropaleontological study of the Carboniferous of the Sahara is in progress. The laboratory has also carried out heavy-mineral studies, granulometry, and a micropaleontological study of the Cretaceous-Tertiary contact in the Mesogean area (1955, 4th World Petroleum Congress, sec. 1/D).

JEAN CUVILLIER
Centre d'Études de Micropaléontologie
University of Paris

GREAT BRITAIN

TOM BARNARD

Your correspondent is pleased to report that research on problems of British micropalaeontology is continuing to receive increased attention. It is unfortunate, however, that much of the work done by students for theses does not appear in print. In Britain we still suffer from the lack of any recognised centre for micropalaeontology, a branch of palaeontology much neglected in a country where a great deal of the pioneer work on macrofossils took place. The following reports have been received from various university departments of geology and oil companies:

University of Birmingham

In addition to pollen studies on various late glacial and interglacial deposits in the Midlands, extensive collections are being made of other microfossils from these beds. The most important of these is a collection of beetle remains, of which a large number of species have now been found and which promise to yield very interesting information on the ecology of the Pleistocene deposits. Amongst more usual microfossil studies, the search for conodonts and small vertebrate remains in the Silurian (chiefly Ludlow) rocks of the Welsh Borders has continued, and collections have been made from a large number of horizons.

University of Cambridge Sedgwick Museum

M. Black is continuing work on the composition of Cretaceous chalk and on the finer fractions of *Globigerina* ooze. N. F. Hughes, F. R. Gnauck (of the British Petroleum Co. Ltd.), and Miss M. G. Bagot are continuing their work on plant microfossils and other associated fossils of the Mesozoic and lower Tertiary; particular attention is being paid at present to the Lower Cretaceous. A preliminary study of British Mesozoic spores and pollen by R. A. Couper, who has now returned to New Zealand, will be published this year. C. L. Forbes' work on the Carboniferous and Permian fusulines of Spitsbergen is approaching completion.

University of Hull

The following micropalaeontological studies are now being carried on:

1) On microfaunas from the Speeton clay (Lower Cretaceous) at Speeton and in adjacent boreholes;

2) On microfaunas from the Kimmeridge clay of the type section and of the Speeton area;

3) On Ostracoda from the Barton beds at Barton;

4) On microfaunas from the basement and sub-basement beds of the Pleistocene at Dimlington, Yorkshire; and

5) On microfaunas from the lower Lias of Hotham, Yorkshire.

University of Southampton

Mr. Shelford is continuing his research on Albian foraminifera from southern and southwestern England.

University of London University College

Tom Barnard is continuing his work on the zonation of the Chalk and Lias by means of foraminifera, and has almost completed a major piece of research on the classification, evolution, and morphology of the Lagenidae. A. Lloyd now has his studies of foraminifera from the Kimmeridge clay of the type area in Dorset almost ready for publication. This piece of research not only deals with the systematic description of the faunas, but also contains studies of variation in populations, as well as studies of the evolution of certain species groups.

E. Robinson is continuing his comprehensive studies on the Ostracoda of the Lower Carboniferous. He has also studied a large number of thin sections from various microfacies of the Lower Carboniferous in northern England. It is hoped that these results will soon be published.

M. Hughes-Clark has almost completed his research on selected genera and species of Albian ostracodes from some English localities. S. McNichol has recently left to take up a post with Imperial Oil Ltd. in Canada; it is to be hoped that his work on the Bathonian (Middle Jurassic) foraminifera of southern England will soon be completed for publication.

W. A. Gordon left earlier in the year to take up a teaching post in Vera Cruz. His research on the foraminifera of the Corallian of England is continuing. D. A. Rasheed, working on the ecology, variation, and systematics of Recent foraminifera from the Coral Sea, has now almost completed his research. Interesting data on ecology and wall structure have been obtained, and will soon be published.

F. Banner spent three months of his recent leave at University College, working jointly with Tom Barnard on Cretaceous arenobuliminids. A paper on the evolution, morphology, internal structure, and stratigraphic applications of this complicated group is soon to be presented for publication. During the next session, a full-year course in micropalaeontology is being introduced for postgraduates. It is proposed to deal with the elements of all branches of the subject.

University of Wales
University College, Aberystwyth

Professor Alan Wood is continuing his research on the wall structure of the foraminifera. D. J. Jenkins, who has been studying Australian Tertiary foraminifera, will be returning from Australia in August, 1957. Research students are continuing their work on Lower Cretaceous, Lower Jurassic and Recent foraminifera of the British area.

University of Wales
University College, Swansea

Professor F. H. T. Rhodes is continuing his work with Dr. D. L. Dineley on the Devonian conodont faunas of Britain. Two papers have recently been published by them (1956, Geol. Mag., and 1957, Jour. Pal.). Professor Rhodes has completed a study of the Neurodontiformes, on which a paper has just been published in the "Journal of Paleontology." He is continuing his studies on the hystrichosphaerids, on conodonts, on Devonian foraminifera from Illinois, and on a large and varied Cambrian microfauna from New Zealand.

The British Petroleum Company

Drs. F. E. Eames and W. J. Clarke have been working on material from Mesozoic and Tertiary rocks of East Africa, North Africa and Sicily. F. C. Dilley has gone to Papua, and Dr. E. Schijfsma has been stationed in Dar es Salaam. Dr. F. T. Banner has returned from Papua and is studying Mediterranean Tertiary faunas. J. A. Seymour, after several months in East Africa, is working in London on Upper Cretaceous faunas. W. H. Blow is stationed in Malta, where he is working on Mediterranean Cretaceous and Tertiary material, paying special attention to planktonic forms. Miss S. J. de Renzy is assisting Dr. Schijfsma in East Africa.

Iraq Petroleum Company

G. F. Elliott is continuing his studies on calcareous algae. A. H. Smout is compiling data on nummulites and preparing a note on spirals in foraminifera. A revision of the Peneroplidae of the Middle East is also well advanced.

British Museum (Natural History)

Dr. C. G. Adams has been appointed to take charge of the collections of fossil foraminifera. Both fossil and living Protozoa are curated, for administrative reasons, in the Department of Zoology. Dr. R. H. Hedley is at present engaged in a study of certain aspects of test formation in living foraminifera, and Dr. Adams is continuing his work on the microfaunas of the Lower and Middle Jurassic of eastern England.

It is with deep regret that we record the death on March 1, 1957, of A. G. Davis, who had worked in this Section as an Associate since the resignation of C. D. Ovey in 1953. Mr. Davis will be greatly missed by his colleagues and by other friends in the field of micropalaeontology.

Other news

At the British Association Meeting, held at Sheffield, a full session was devoted to micropalaeontology. The following papers were read, and proved to be of great interest:

Professor L. R. Moore: *Some microfossils from a chert in the Scottish Oil Shales.*

Unusual preservation of material in this chert has thrown much light on the nature of the microfossils which largely contribute to the carbonaceous matter in the Scottish Oil Shales.

Dr. C. Downie: *Microplankton from the Shineton shales preserved in organic matter.*

A preliminary account of the hystrichospheres that occur abundantly in the Shineton shales.

L. G. Love: *A new group of microorganisms from Carbonaceous rocks.*

Micro-organisms found in association with iron sulphide in the Oil Shale group of the Lower Carboniferous of Scotland are described, together with the micropalaeontological methods used.

Dr. T. Barnard: *Microfossils from the Chalk.*

The general distribution and significance of some microfossils from the Chalk. Their value to the stratigrapher and sedimentologist.

Dr. J. E. Robinson: *Some aspects of the micropalaeontology of the Scremerston Coal group.*

An account of variation in ostracode faunas within a carbonaceous division of the Avonian of Northumberland.

A. J. Lloyd: *Arenaceous foraminifera in the Kimmeridge clay.*

The classification and distribution of arenaceous foraminifera in dominantly argillaceous beds, the Kimmeridge clay of the Dorset coast.

During September your correspondent organised a meeting in England which was attended by sixty of our colleagues from France, Germany, the Netherlands, Belgium, Denmark, North Africa and America. After an outline of the meeting had been given at H.M. Geological Survey Museum, followed by a reunion dinner in London, excursions were conducted to the more important classic localities of Mesozoic and Tertiary rocks on the Isle of Wight (Hampshire) and in Dorset. These meetings aid discussion and mutual exchange of ideas. Although no formal papers are arranged, the maximum time being spent in the field, the value of such an exchange of ideas whilst on the collecting ground cannot be overestimated.

This year the Geological Society of London has awarded the Lyell Fund to F. H. Rhodes and Tom Barnard.

TOM BARNARD
University College
University of London

SPAIN

GUILLERMO COLOM

New workers in the field of micropaleontology in this country are Dr. A. Perconig, of Italy, director of the micropaleontological laboratory established near Madrid by "Adaro" (a Spanish company whose interests include petroleum investigation), and his assistant, Dr. J. Saavedra. Numerous species of foraminifera are being identified from a large amount of material (chiefly Tertiary) obtained from surveys and borings in the Andalusian region. The results will add greatly to our knowledge of Iberian stratigraphy.

Srta. C. Bonet, of the University of Oviedo, and Dr. S. J. Dijkstra have published an extensive paper on Carboniferous megaspores from La Camocha, a locality in the province of Gijon. A detailed description is given of the megaspores found in this Asturian basin, and they are compared with their counterparts from coal basins in the Dutch province of Limburg, in Turkey, and in Poland. On the basis of these comparisons and of other paleobotanical studies, it is concluded that the age of the deposits at La Camocha is lower and middle Westphalian. This paper is profusely illustrated and carries an extensive abstract in English (1956, Estud. Geol., nos. 31–32).

Srta. Menendez Amor, head of the palynological laboratory of the Museo de Ciencias Naturales, Madrid, is continuing her study of samples from fossil peat bogs, deposits of Quaternary slime, and similar deposits, with the object of obtaining more precise knowledge of the various stages of the Quaternary in Spain.

A paper by Drs. N. Grékoff and G. Deroo on Spanish Ostracoda was published last year (1956, Estud. Geol., nos. 31–32). All the species described were found to be related to Middle Cretaceous (Cenomanian and Turonian) forms of Europe and North Africa. Interesting stratigraphic correlations can be established on the basis of some of these species. Five new species were described. One, *Cyprideis iberiacus*, is characteristic of a brackish medium, in contrast to the other four, which belong to biotopes of normal salinity.

Srta. Trinidad del Pal, of the University of Madrid, is continuing her studies of the Miocene and Pliocene foraminifera of the region of Seville. Your correspondent has obtained numerous species of foraminifera and ostracodes from samples collected by Professor L. Solé, of the University of Barcelona, from Miocene, Pliocene and Quaternary formations along the coasts of Tarragona, Valencia and Alicante. Descriptions of three new species of foraminifera were published recently (1957, Estud. Geol., no. 33).

GUILLERMO COLOM
Soller, Majorca

UNITED STATES – EAST-CENTRAL

ROBERT V. KESLING

University of Chicago

Dr. Cesare Emiliani has left the University of Chicago and joined the staff of the Marine Laboratory, University of Miami, Coral Gables, Florida.

Indiana University

T. G. Perry, of the Department of Geology at Indiana University, is studying the bryozoan fauna of the Brownsport formation (Middle Silurian) of western Tennessee. This research project was initiated in August, 1956, and is supported by a research grant from the Geological Society of America. A preliminary comparison has been made with the bryozoan fauna of the Henryhouse shale of Oklahoma, through the kindness of Dr. Thomas W. Amsden, who furnished Henryhouse specimens.

Dr. David G. Frey, Professor of Zoology, has a paper in press to appear soon in the "Archiv für Hydrobiologie," entitled "The late glacial cladoceran fauna of a small lake." The fauna was found in Lake Wallensen, near Hannover, Germany, which has now been destroyed by mining in the brown-coal area. Dr. Frey is presently working jointly with Helmut Müller, palynologist with the German Geological Survey, on collections from Lake Schleinsee in southern Germany. Müller is working on a pollen diagram of the lake, while Frey is doing the animal microfossils and chemistry, all of which they expect to tie together. Of special interest in the project is a 1½-meter stratum of alternating fine laminae of calcareous and organic materials. These are annual layers, on the basis of pollen counts, and Müller has been able to gain an idea of time between successive early neolithic cultures through their study.

Indiana Geological Survey

G. G. Guennel, paleobotanist in the Coal Section, reports the following activities: A report entitled "A miospore analysis of the Pottsville coals of Indiana" is in the process of publication by the Indiana Survey. A joint project by Guennel and H. H. Gray, geologist, is in progress to determine whether spore data can be more readily utilized via IBM procedure. Guennel is continuing miospore studies of Indiana coals, and is presently working on the Coal VI- and Coal VII-Millersburg coal complex, Warrick County, and on coals from the Dickburg Hills and Merom cores. The Millersburg problem is local but of considerable interest in relation to mapping coal

beds as part of the Indiana resources studies.

The Indiana Survey has just published Bulletin no. 10, entitled "A Middle Pennsylvanian foraminiferal fauna from Dubois County, Indiana" (1957, 66 pp., 5 pls.). The report includes the first published descriptions of fusulinids from Indiana. The author is Joseph St. Jean, Jr., now at Trinity College.

Within the past year, the Survey has organized a new Paleontology Section. One of its first major programs envisages a series of studies on Carboniferous microfaunas, especially Ostracoda and Fusulinidae. Studies are now under way by Guennel on Mississippian Ostracoda. A paper by Robert H. Shaver, head of the Paleontology Section, entitled "A study of *Pseudobythocypris pediformis*, a new name for an old ostracod," is in press and will soon appear in the "American Midland Naturalist."

Notre Dame University

R. C. Gutschick and one of his senior students, John Treckman, are studying a very interesting Lower Mississippian arenaceous foraminiferal fauna from northern Indiana, which they hope to write up during the summer. Beds of Rockford age contain a prolific and fairly diversified insoluble-residue fauna. Dr. Gutschick and Tom Perry, of Indiana University, will be at Indiana University's summer camp and plan to study Lower Mississippian foraminifera from Montana. They will extract material by using acid in the field. Dr. Winkler is continuing work on ostracodes.

University of Michigan

Members of the advanced micropaleontology class have written a paper on a new genus of beyrichiid ostracodes, which will be published soon. Recent publications in the Contributions from the Museum of Paleontology include "A chart useful for study of ostracod carapaces," and "A new genus and species of ostracod from the Middle Devonian Ludlowville formation in western New York," both by R. V. Kesling. Papers in press include "A peel technique for ostracod carapaces and structures revealed therewith in *Hibbardia lacrimosa* (Swartz and Oriel)," and "Origin of beyrichiid ostracods," both by Kesling, and "Ontogeny and ecology of *Welleria aftonensis* Warthin," by Kesling and George C. Soronen.

Kesling has also published "Notes on Zenker's organs in the ostracod *Candona*," in the American Midland Naturalist. A paper entitled "Size, lobation, velate structures, and ornamentation in some beyrichiid ostracods," by Kesling and Kenneth J. Rogers, has been accepted by the Journal of Paleontology.

Rex M. Peterson is restudying the Middle Devonian hollinids of the Falls of the Ohio. Dr. George M. Ehlers and Kesling are describing a new beyrichiid genus from the Middle Silurian Manistique formation in northern Michigan. They have also discovered an unusual spined species of *Herrmannina*.

Ohio State University

Dr. Charles S. Summerson has just completed a paper to be published in the Journal of Paleontology on "Arenaceous foraminifera from the Columbus limestone." Another paper, on "Pennsylvanian holothurians," is in the late stages of preparation.

Two Masters' theses on conodonts from the Eden group (Upper Ordovician) of southwestern Ohio were completed in June, 1957, by Earl Warner and Lorna Wilkie. Another Master's thesis, a part of the same project, is being written by Carol Turco, and will be completed during the summer. Elaine Jones is beginning work on a Master's thesis on ostracodes from the Economy member of the Latonia formation, Eden group. These are all parts of a general restudy of the Ordovician rocks of Ohio being undertaken jointly by the Ohio State University and the University of Cincinnati.

Dr. Mildred F. Marple is continuing to work on Pennsylvanian microfaunas. She is also busy with a translation of Triebel's 1940 paper on the morphology and ecology of ostracodes.

United States Geological Survey
Coal Geology Laboratory, Columbus, Ohio

Studies by J. M. Schopf on plant microfossils in the Pennsylvanian of Alabama and Kentucky are in progress. Systematic analyses will be published, but the work is primarily for assistance in preparing detailed geologic maps of the coal measures in these states.

University of Cincinnati

We are saddened to learn of the death of Dr. John H. Hoskins, of the Department of Botany, who had been studying Paleozoic spores.

James E. Conkin taught a graduate-senior course in micropaleontology the second semester this year, in the Department of Geology. He is working on a Ph.D. thesis, under the direction of Dr. K. E. Caster, to be entitled "Smaller foraminifera of the Mississippian of eastern North America." The actual areas embraced in this study include all of Ohio (eastern), Kentucky (both sides of Cincinnati arch), southern Indiana, Missouri, southern Iowa, and southwestern Illinois.

James E. Conkin and Barbara M. Conkin have completed the manuscript of a paper entitled "Revision of the miliolid genus *Nummoloculina*," to be submitted for publication in "Micropaleontology." Ronald Perkins has completed a senior thesis entitled "Use of charophytes in Pleistocene-Pliocene differentiation in the Gulf Coast of Texas." This study was directed by Dr. K. E. Caster and James Conkin.

University of Dayton

Dr. H. N. Coryell writes: "Micropaleontological studies of foraminifera, Ostracoda and other microforms and their ecological relationships and stratigraphic uses have formed a part of the schedule in the Department of Geology at the University of Dayton since 1953."

University of Illinois

Dr. Harold W. Scott reports that two Master's theses have been completed this year: "Miocene foraminifera from Pakistan" and "Miocene ostracodes from Pakistan." He adds that a manuscript on the holotype of *Paraparchites* has been completed,

but unfortunately ill health has kept him away from his work for most of the year.

Illinois State Geological Survey

Mrs. Marcia R. Winslow has been studying the megaspore floras of Illinois coal beds since September, 1955, and is currently writing a report which will cover the Chesterian and Lower Pennsylvanian coals through the Harrisburg (No. 5) coal. The report contains the stratigraphic occurrence of megaspore genera and species in Illinois coal beds, as well as numerous descriptions of both old and new genera and species. The report is to be published by the Illinois State Geological Survey, and should be released some time during 1958.

Fred Cropp plans to investigate the small-spore flora of two coal beds of Illinois during the current summer, and Dr. R. M. Kosanke expects to carry out this project with additional coal beds during the latter part of 1957 and 1958. Ultimately, the Survey hopes to record the spore flora for all of their coal beds.

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Museum of Paleontology
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UNITED STATES – ROCKY MOUNTAIN REGION

R. M. STAINFORTH

General

At the S.E.P.M. annual meeting in St. Louis your correspondent enjoyed meeting many colleagues. Speakers from the Rocky Mountain region included Christina Lochman Balk, Donald A. Myers and Daniel J. Jones. A study of charophyte evolution in the Morrison formation was presented by Charles A. Ross of Yale University.

Some recently published studies are too wide in scope to be reported as state activities. They include a paper on Mississippian endothyroid foraminifera by Edwin J. Zeller, in which five zones are recognized over a region including Arizona, Montana, Nevada, Utah and Wyoming (Jour. Pal., vol. 31, pp. 679–704); a thoughtful study by James A. Peterson of Jurassic paleogeography in the northern Rocky Mountains, in which passing reference is made to paleoecology of ostracods (Amer. Assoc. Petr. Geol., Bull., vol. 41, pp. 399–440); and a discussion by Helen Duncan of her new genus *Bighornia*, tiny solitary corals found in the Ordovician of Colorado, Idaho, Nevada, Wyoming and elsewhere (Jour. Pal., vol. 31, pp. 607–615).

Apart from its general interest and value, the new treatise on paleoecology (Geol. Soc. Amer., Mem. 67) contains material of special concern to Rocky Mountain paleontologists, notably the chapters on the Cambrian in Montana and Wyoming (Lochman); Permian reefs in the Guadalupe Mountains (Newell); the Lower Triassic of the Idaho area (Kummel); the Jurassic (Imlay) and the Cretaceous (Reeside) of the Western Interior.

Arizona

John F. Lance reports that little research work is in progress at the University of Arizona, Tucson. Donald L. Bryant had started work on Pennsylvanian-Permian fusulines, but he left for Brazil before analyzing the fauna. The course in micropaleontology has been taken over by Halsey Miller. Palynological study of the Pennsylvanian Horquilla formation is scheduled.

Recent papers include one on Mississippian holothurian sclerites from the Escabrosa limestone by R. L. Langenheim and R. C. Epis (Micropaleontology, vol. 3, pp. 165–170). Reference to Devonian conodonts and Pennsylvanian-Permian fusulines is made in a stratigraphic study of southeast Arizona by F. S. Sabins (Amer. Assoc. Petr. Geol., Bull., vol. 41, pp. 466–510).

Colorado

J. Harlan Johnson reports on activities at the Colorado School of Mines, Golden. The study of Mississippian algae by Johnson and K. Konishi (Colo. Sch. Mines, Quart., vol. 51, no. 4) is to be followed by a similar paper on Devonian algae (*idem*, vol. 53, no. 1, in press). In the same series is a well-organized and annotated bibliography (1942–1955) of fossil algae by Johnson (*idem*, vol. 52, no. 2). Due for publication shortly is a description of fossil algae from Saipan (U. S. Geol. Survey, Prof. Paper 280-E, in press), to be followed by a similar study of material from Guam. Dr. Johnson has retired from teaching and expects to make further research on fossil algae his full-time occupation.

Richard Rezak gives the following information on micropaleontological activity (currently all paleobotanical) at the Geological Survey in Denver. He himself is studying fossil algae, with emphasis on the Dasycladaceae, and has several short papers ready for publication. One of these will refer to the discovery, in Florida, of Eocene Dasycladaceae similar to forms described from the Paris Basin by the Morellets; it is expected that further study of the Gulf Coast Tertiary will reveal as rich an algal flora as in the Paris Basin. Current investigations include a systematic and ecologic study of modern algae from the Bahama Banks; a comprehensive study of Permian Dasycladaceae in North America; and a study of the possible use of Coccolithophoriidae in correlation within the Cretaceous of the Western Interior.

Richard A. Scott has been working on fossil wood and spores from the Jurassic and Triassic of Utah and is now preparing a manuscript, with Grace Sommers Brush, on this work; the material proved to contain types already named from the Upper Paleozoic, many apparently new forms, and none that could be called angiosperms. Scott is also

working on a second comprehensive paper (see Palaeontographica, 1954, vol. 96, pp. 66–97) on fossil fruit and wood from the Eocene Clarno formation of Oregon, a flora taxonomically similar to that of the London Clay, ecologically analogous to modern tropical forests of the Old World.

Estella B. Leopold has been working on Tertiary pollen floras of the Great Basin, attempting to determine general floristic trends. She has made comprehensive palynological studies of the Oligocene Florissant and Miocene Creede formations of Colorado, the Florissant pollen revealing several Old World temperate woody genera not recorded in the leaf flora of the formation. These western studies follow her recent work on glacial peat in New England (Nat. Acad. Sci., Proc., vol. 52, pp. 863–867; Grana Palynol., vol. 2, pp. 110–116).

Montana

Robert W. Fields reports only one micropaleontological project in progress at Montana State University, Missoula. This is by graduate student Charles Achauer, and is a palynological study of the Sappington formation. It is hoped that this new approach to an old problem may establish the Devonian-Mississippian contact with more certainty.

Philip A. Mundt refers to Carboniferous microfossils in a stratigraphic paper on central Montana (Amer. Assoc. Petr. Geol., vol. 40, pp. 1915–1934). James L. Wilson draws attention to a thin but widespread Upper Devonian zone, characterized by the branchiopod *Rhabdostichus* cf. *R. pulex* and traceable from outcrops in the Montana Rockies eastward to the deep subsurface of the Williston Basin (Jour. Pal., vol. 30, pp. 959–965).

Nevada

Joseph Lintz, Jr., tells us that no micropaleontological studies are in progress at the University of Nevada, Reno. However, several recent papers in the Journal of Paleontology refer to Nevada microfaunas. Two are on fusuline assemblages, one Pennsylvanian (G. J. Verville, M. L. Thompson and D. H. Lokke, vol. 30, pp. 1277–1287) and one Permian (R. L. Knight, vol. 30, pp. 773–792). A subject of more than passing interest is discussed by K. J. Müller, namely Triassic conodonts; this appears to be the very first illustrated description of Mesozoic conodonts in world literature (vol. 30, pp. 818–830).

New Mexico

Christina Lochman Balk, writing for both the State Bureau of Mines and Mineral Resources and the New Mexico Institute of Mining and Technology, Socorro, mentions work done on fusulines, by M. L. Thompson, and on *Endothyra-Plectogyra* assemblages, by E. J. Zeller. These studies have been partly recorded in Circular 39 (1955) and Memoir 1 (1956) of the Bureau. During routine well-sample studies at the Bureau, R. A. Foster and J. Biebermann have noted the Upper Cretaceous index species *Epistomina caracolla*. At the Institute a course in micropaleontology has been added to the curriculum in geology, to be taught by Dr. Balk (as is most of the geology at Socorro).

At the University of New Mexico, Albuquerque, another new course in micropaleontology has been started, with an initial enrollment of twenty students. This is being organized and taught by Roger V. Anderson, who writes enthusiastically of his plans to study such topics as Upper Cretaceous palynology of the San Juan Basin, Pennsylvanian arenaceous foraminifera, Paleozoic bryozoa, and ethno-palynology of Early Man sites and cave deposits. Meanwhile he is completing a Ph.D. thesis at Stanford on a palynological theme.

Among recent papers, the description by H. L. Strimple and J. W. Koenig of a rich Mississippian assemblage of microcrinoids is of special interest; the fauna was collected in shale partings in limestones and establishes correlation between the Lake Valley formation of New Mexico and the St. Joe formation of Oklahoma (Jour. Pal., vol. 30, pp. 1225–1247). Brief mention of Paleozoic microfaunas is made by W. R. Muehlberger (Amer. Assoc. Petr. Geol., Bull., vol 41, pp. 140–145), J. P. Fitzsimmons, A. K. Armstrong and M. Gordon (*idem*, vol. 40, pp. 1935–1944) and M. L. Thompson, G. J. Verville and D. H. Lokke (Jour. Pal., vol. 30, pp. 793–810).

Wyoming

G. J. Verville (Jour. Pal. vol. 31, pp. 349–352) caused something of a stir by recording a Permian (Wolfcampian) assemblage of *Schwagerina* and *Triticites* in the Tensleep formation. This unit has been almost pigeon-holed in the Pennsylvanian, but, as Verville points out, consideration of pre-Phosphoria truncation and Permo-Pennsylvanian lithofacies left room to expect Permian Tensleep in east-central Wyoming.

Loris S. Russell ventures into a neglected field in discussing freshwater micromollusks from the late Miocene of Wyoming (Jour. Pal., vol. 30, pp. 1260–1263).

Oil-company activities

Exploration for petroleum continues actively in the Rocky Mountain states, and major discoveries are being made, as at Aneth in Utah and Outlook in Montana. Undoubtedly micropaleontology is being applied in the stratigraphic phase of exploration. However, the scant information available as to personnel, locations and projects is clearly not representative. Perhaps more of this non-confidential information will be received for our next report, but for the present, only mention of transfers will be made here. From Casper, Wyoming, R. L. Heacock informs us that Mrs. Mary Gilman Clark and Mrs. Edith Dobbins Schmechel have left the Shell laboratory to join their husbands in Ankara, Turkey. Paul J. O'Donnell, a graduate of the University of Nebraska, has joined the Shell micropaleontology staff in Casper. L. Weiss left the Carter office in Billings, Montana, to return to Peru; his replacement is Harry W. Anisgard, formerly with Creole in Venezuela.

R. M. Stainforth
Carter Oil Company
Billings, Montana

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